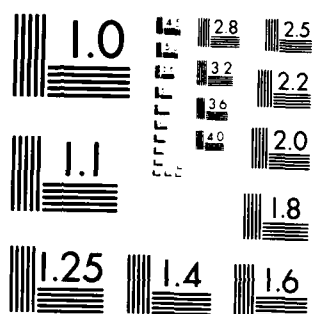


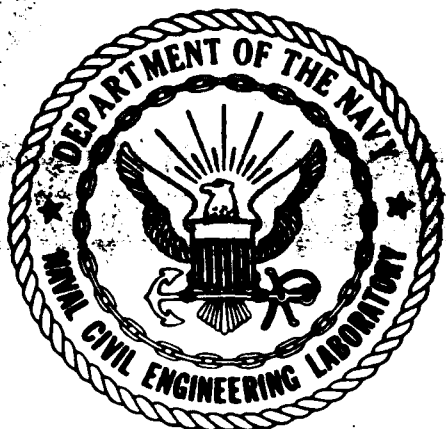
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MICROCOPY RESOLUTION TEST CHART
NATIONAL BUREAU OF STANDARDS-1963-A

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NAVAL CIVIL ENGINEERING LABORATORY
Port Hueneme, California

Sponsored by
NAVY ENERGY & NATURAL RESOURCES
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EMCS INSTALLATION FOLLOW-UP STUDY
VOLUME II OF II

March 1984

An Investigation Conducted by
NEWCOMB & BOYD
One Northside 75, Ste 200
Atlanta, GA 30318

REQ3066-7880

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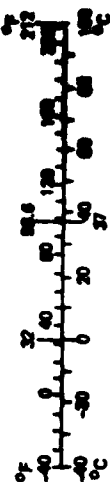
METRIC CONVERSION FACTORS

Approximate Conversions to Metric Measures

Symbol	When You Know	Multiply by	To Find	Symbol
in ft yd mi	inches	2.5	centimeters	cm
	feet	30	centimeters	cm
	yards	0.9	meters	m
	miles	1.6	kilometers	km
in ² ft ² yd ² mi ²	square inches	6.5	square centimeters	cm ²
	square feet	0.09	square meters	m ²
	square yards	0.8	square meters	m ²
	square miles	2.6	square kilometers	km ²
	acres	0.4	hectares	ha
oz lb	ounces	28	grams	g
	pounds	0.45	kilograms	kg
	short tons (2,000 lb)	0.9	tonnes	t
tsp Tbsp fl oz c pt qt gal cu ft cu yd	teaspoons	5	milliliters	ml
	tablespoons	15	milliliters	ml
	fluid ounces	30	milliliters	ml
	cups	0.24	liters	l
	pints	0.47	liters	l
	quarts	0.96	liters	l
	gallons	3.8	liters	l
	cubic feet	0.03	cubic meters	m ³
	cubic yards	0.76	cubic meters	m ³
°F	Fahrenheit temperature	5/9 (after subtracting 32)	Celsius temperature	°C

Approximate Conversions from Metric Measures

Symbol	When You Know	Multiply by	To Find	Symbol
mm cm m km	millimeters	0.04	inches	in
	centimeters	0.4	inches	in
	meters	3.3	feet	ft
	kilometers	1.1	yards	yd
		0.6	miles	mi
cm ² m ² km ² ha	square centimeters	0.16	square inches	in ²
	square meters	1.2	square yards	yd ²
	square kilometers	0.4	square miles	mi ²
	hectares (10,000 m ²)	2.5	acres	ac
g kg t	grams	0.036	ounces	oz
	kilograms	2.2	pounds	lb
	tonnes (1,000 kg)	1.1	short tons	
ml l m ³ m ³	milliliters	0.03	fluid ounces	fl oz
	liters	2.1	pints	pt
	liters	1.06	quarts	qt
	liters	0.28	gallons	gal
	cubic meters	35	cubic feet	cu ft
	cubic meters	1.3	cubic yards	cu yd
°C	Celsius temperature	9/5 (then add 32)	Fahrenheit temperature	°F



*1 in. = 2.54 (exactly). For other exact conversions and more detailed tables, see NBS Mon. Publ. 288, Units of Weights and Measures, Price \$2.25, SD Catalog No. C13.10-288.

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REPORT DOCUMENTATION PAGE		READ INSTRUCTIONS BEFORE COMPLETING FORM
1 REPORT NUMBER CR 84.024	2 GOVT ACCESSION NO	3 RECIPIENT'S CATALOG NUMBER
4 TITLE (and Subtitle) EMCS Installation Follow-up Study Volume II of II		5 TYPE OF REPORT & PERIOD COVERED Final Apr 1983 - Mar 1984
		6 PERFORMING ORG REPORT NUMBER
7 AUTHOR(s) Steve Bruning		8 CONTRACT OR GRANT NUMBER(s) REQ3066-7880
9 PERFORMING ORGANIZATION NAME AND ADDRESS Newcomb & Boyd One Northside 75, Ste 200 Atlanta, GA 30318		10 PROGRAM ELEMENT PROJECT TASK AREA & WORK UNIT NUMBERS Z0371-01-221D
11 CONTROLLING OFFICE NAME AND ADDRESS Naval Civil Engineering Laboratory Port Hueneme, CA 93043		12 REPORT DATE March 1984
		13 NUMBER OF PAGES 256
14 MONITORING AGENCY NAME & ADDRESS (if different from Controlling Office) Navy Energy and Natural Resources R&D Office Naval Facilities Engineering Command		15 SECURITY CLASS (of this report) Unclassified
		15a DECLASSIFICATION DOWNGRADING SCHEDULE
16 DISTRIBUTION STATEMENT (of this Report) Approved for public release; distribution is unlimited.		
17 DISTRIBUTION STATEMENT (of the abstract entered in Block 20, if different from Report)		
18 SUPPLEMENTARY NOTES		
19 KEY WORDS (Continue on reverse side if necessary and identify by block number) EMCS, Energy monitoring and control systems		
20 ABSTRACT (Continue on reverse side if necessary and identify by block number) This report contains the site visit reports of all the sites visited in the Kings Bay Master Plan/Feasibility Study for implementing EMCS and follow-up visits.		

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INTRODUCTION - VOLUME II

This report provides the Task 3 deliverables for an EMCS Installation Follow-Up study. The objective of this study is to provide data on experience at existing EMCS installations for use in developing guidelines for better implementation of EMCS. Task 1 of the study provides for review of data gathered in past studies. Task 2 of the study involves visiting sites included in those past studies to determine the effectiveness of corrective actions taken at those sites to improve EMCS performance. Task 3 summarizes the Task 1 and 2 findings and provides a report recommending actions to enhance the successful implementation of EMCS.

This study is being performed for the Navy Civil Engineering Laboratory, Port Hueneme, California, by Newcomb & Boyd Consulting Engineers, Atlanta, Georgia.

VOLUME I of this report provides discussion and findings of the study. The VOLUME II contains site visit notes and other data used in preparation of VOLUME I.

APPENDIX A - SITE VISIT NOTES

The site visit notes included in this Appendix have been reviewed by the attendees at the various meetings. The notes were distributed to meeting attendees with a request for corrections or clarifications. Comments were incorporated in the site visit notes included in this version of the report. Where site visit notes refer to attached data, see Appendix B.

KINGS BAY COMMUNICATIONS STUDY

SITE VISIT NOTES

TRIDENT SUBMARINE BASE
BANGOR, WASHINGTON
OCTOBER 21, 1980

ATTENDEES:

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Pete Walmsley	Trident East	(912)697-2341

The EMCS at Trident Bangor was originally planned as a Fire Alarm System in 1974. It was to replace an existing Gamewell System. Early in its planning it was decided to expand the system to pick up certain alarms throughout the Base that were non-fire related. In late 1974 Pete Walmsley (who was then with Bovay Engineers) was in the process of designing an electrical supervisory control system and a water plant control system. The initial concept for those systems was to use the same communication network for water plant control, electrical supervisory control, and a fire and other alarm system. The original project was a two-step procurement and specified that coax cable be used for the communication network. This was respected by the Navy as being too restrictive and proprietary. The specifications were modified and an alternative using paired telephone cable was included along with the coax cable.

The contracting firm of Wisemer and Becker got the job with Esterline as the supplier of electronic gear. It was approximately a \$3,000,000 contract. Honeywell was the second low bidder and was approximately \$100,000 above Wisemer and Becker's price. There were 30 initial proposals on the two-step process, but only 6 were finally allowed to bid. The system was to include all communications cables by the contractor, no Government furnished leased lines were included.

Anticipating completion of the EMCS, some buildings were constructed with data terminal cabinets and the points for the EMCS were included in the building construction. Those points were never tested when the buildings were constructed and,

therefore, when Wismer & Becker attempted to connect them into the EMCS they were found not to be operable. One of the elements of the study for Kings Bay should be to look at different methods of testing. One possibility would be to specify that the contractor will provide the testing with certification by an independent engineer or a testing agency. Another possibility would be to create a NAVFAC testing team.

The EMCS at SUBBASE Bangor was never operational. It currently is disconnected, all the central gear is shut down. An expansion project is underway which will double the points connected to the system and place it in operational condition. This expansion was designed by Wood/Harbinger Inc., of Seattle and the contractor is Oak-Adec. The contract was awarded within the past two months. The expansion project will completely replace all existing central hardware and software and all field multiplex panels. Most of the sensors will be reused and the transmission cable will be reused. Prior to reuse, the transmission cable will be tested by the contractor and if found not to be acceptable will have to be replaced by the Government. The expansion design was begun in 1978 while the Wismer and Becker system was still under construction. The original intent of the expansion design was simply to add additional buildings and points to the system that Wismer and Becker was installing. As the construction and operation of the original system was delayed, it became obvious that the expansion would essentially have to be a replacement of much of the central gear and many of the field panels.

Contractor Quality Control (CQC) procedures caused problems with the original installation because the contractor would simply certify that the installation was correct. Many times this was proven not to be the case at a later date. But because of the CQC procedures, the contractor was able to certify his own mistakes. The ROICC offices are not staffed to do the specialized inspections required of an EMCS (such as cable splicing). Even if the ROICC attempted to staff with such specialized people they probably would not be able to obtain them with the Government pay scales for inspectors. One possibility would be to have the design A&E do the inspection.

The Wismer and Becker system was found to have many sensors in improper locations. Due to this problem, the expansion design utilized a yellow sticker system to try to avoid that problem. The designers would physically place a sticker marked in indelible ink at the location in the field where a particular point was to be installed. The design drawings for the expansion showed system locations but did not show point locations since these were defined by the stickers. The stick-

ers must be of a high quality material and be non-removable. As a part of the expansion project the contractor will remove MUX panels, remove central computer hardware and software, and test all existing sensors.

The Wisemer & Becker system was never fully operational, although the CQC procedures certified that all points were operational. Tests by Wood/Harbinger showed that points did not work. Wisemer and Becker then fixed those points, but others failed in the meantime.

Many of the problems encountered on the initial installation were due to the fact that the Government did not clearly define what was wanted. The performance specifications prepared by Bovay Engineers did not provide a good definition of the specifics of the system. The contractor had a very comprehensive system for monitoring change orders while having a very poor system for actually performing the work. Bovay Engineers were not involved in checking the contractor's design, which proved to be a mistake. Other problems centered on the timing of the massive scale of construction on the Base. There were many occurrences of digging up of communication cables by the Government and other contractors on other construction projects after the Wisemer and Becker contractors had already installed the underground work. The contractor's design was prepared from "as-built" building drawings which were furnished by the Government and were found, in many cases, to be incorrect. Therefore, faulting the contractor's design was very difficult from a legal standpoint. Wismer and Becker received poor support from Esterline and a difficult relationship developed.

The original operator concept for the Wisemer and Becker system was to use the Base maintenance contractor (Pan Am) to provide operators. Pan Am was never ready to provide those operators. The expansion plan has the EMCS contractor operating the system for a substantial phase-in period at which time either Government employees or Pan Am employees will be phased in to operate the system.

It was pointed out that the construction contract must be awarded with some operations and maintenance money included for operations and maintenance in order to keep operations and maintenance funds involved through the construction process and to have accounts open after termination of the contract.

Telephone cable splicing resulted in a number of problems. The splicing done at SUBBASE Bangor was performed by electrical union workers instead of communication union workers because of labor rulings in the area. The splicing was very poorly done and, as a result, there have been a number of cable problems.

An A&E Guide has been prepared by Wood/Harbinger for an EMCS interface at Bangor and Newcomb & Boyd will obtain a copy of that.

PLANNING MEETING NOTES

OCTOBER 21, 1980

8:00 P.M.

BREMERTON, WASHINGTON

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Alan Toelle	Wood/Harbinge	(206)821-4242
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The purpose of the meeting was to discuss the expanded scope of the Kings Bay Fire Alarm, Communication, and EMCS Study as it relates to EMCS applications Navy-wide and not just at Kings Bay.

George Novey noted that they had encountered problems at Camp Lejeune with too literal interpretations of the specifications by the inspectors. Another problem he noted was timing of bids. Where bids were due simultaneously for several Bases, the contractors were unable to prepare bids for all sites. Thus, the jobs received fewer bids. Also, the construction schedules included in many of the EMCS projects were too short for the work required.

Alan Toelle, of Wood/Harbinger, related their experience on Western Washington University and a NAVFAC contract at Adak, Alaska.

Western Washington University: The project includes approximately 40 buildings. Robertshaw Controls was awarded the EMCS contract. The A&E was very involved in construction supervision. Honeywell was the original low bidder with a Delta 2000, but the A/E managed to have them excluded from the award since the Delta 2000 did not include a computer and, therefore, did not meet the specifications. Toelle emphasized the need for day-to-day involvement and close Contractor/Owner/A&E coordination.

Adak Alaska: Toelle related their experience at a Naval installation in Adak, Alaska as contrasted to Western Washington University. Both projects occurred in approximately the same time frame. The contract for Adak, Alaska was for a

central monitoring and control system. By the 35% design submittal it was found that most of the basic HVAC systems and controls were inoperable. The project, at that point, was modified to be basically a retrofit of the local controls and upgrading to make the systems operable. No actual central monitoring and control system was included. The scope of the project was roughly \$1.5 million. The project encountered many, many difficulties. Wood/Harbinger Inc. was not involved in construction supervision. There was so much turnover in personnel on the part of the Government that no individual followed the project all the way through and saw that the work was done properly. During the course of the project there were three different Public Work Officers, three Assistant Resident Officers In Charge of Construction, three Mechanical Supervisors, and four different Contractor Superintendents. Toelle indicated that one approach to avoid might be to plan on a large scale, but actually implement in small increments so that the people involved could see a project through all the way from the beginning to the end. A small project could be done in a few months time instead of over a couple of years. Toelle emphasized the need for continuity on a project by the A/E.

The possibility of pre-qualification of contractors or prior experience qualifications was discussed. This has been investigated several times. In each case legal difficulties have caused the elimination of such clauses or procedures.

Different approaches to the investigation of the current status of EMCS within DOD were discussed. The first step is to define a data base of EMCS within the Department of Defense. A catalog of existing Energy Monitoring and Control Systems would be created. This would not be limited to the Department of Defense. A good opportunity for obtaining the data necessary for this catalog will be presented at the EMCS Society meeting to be held in Kansas City in November. At that time information could be obtained from systems suppliers, Government, A&E's, Owners, and Prime Contractors, large and small. The creation of a short form questionnaire was discussed, along with a long form for more detailed information. One way to obtain cooperation in gathering the data would be to provide those who provide data with a copy of the report. It was suggested that the questionnaires be handed out during the Conference. Bruning will prepare such a questionnaire for possible inclusion at the Conference.

During the development of the Army EMCS Design Manual Frank Carlen, of Corps of Engineers, and Jeff Cosiol, of Kling/Lindquist, visited many EMCS sites around the country. No publication of the results of their trip visits has been made. Bruning will check with Frank Carlen to see if notes are available that were taken during their trip to avoid duplication of effort.

One system suggested for examination is located at the University of Toronto.

The conclusion of this meeting was to first gather basic data on as many EMCS installations as possible. Detailed investigation would then be performed on systems selected from the basic list. The EMCS Conference in Kansas City (Nov. 17-21) will be used as a starting point in the gathering of data. During the Conference, further planning for the scope and method of investigation will occur following discussions with EMCS owners, designers, and suppliers.

SITE VISIT NOTES

WESTERN WASHINGTON UNIVERSITY
BELLINGHAM, WASHINGTON
OCTOBER 22, 1980

ATTENDEES:

Steve Brunii,	Newcomb & Boyd
Gardner Chambliss	Newcomb & Boyd
Lee Watson	Newcomb & Boyd
Sam Bryson	NAVFACHQ
George Novey	LANTNAVFAC
Pete Walmsley	Trident East
Alan Toelle	Wood/Harbinger Inc.
Don House	Western Washington Univ.
Larry Johnson	Western Washington Univ.

The Energy Monitoring and Control System at Western Washington University includes approximately 1,900 points, in 40 buildings, connected through approximately 50 field panels. In July of 1977 the central equipment plus approximately 10 of the buildings were on line. By January of 1978, all of the buildings were on line.

The University presented records of their energy conservation efforts over the past ten years. Copies are attached to these notes. These conservation results are primarily due to the implementation of centralized control. The only other large energy conservation effort was a major insulation job on only one of the buildings. The 65° building temperature standards also assist in conservation during the last winter. Results also reflect the fact that there are roughly 600 students more this year than last year (out of a total of roughly 10,000 students). The University now has substantial nighttime and weekend use of the buildings. In the past, buildings were used very rarely at night and on weekends. The University is now paying 48¢ per therm for natural gas. Prior to obtaining central control the steam was shut off by roving patrols at approximately 11:00 p.m. at night and restarted at approximately 4:00 in the morning by another roving patrol.

The energy conservation results also should be viewed in light of the fact that the site now has 44 buildings, but at the beginning of the records only 10 buildings were existing. A major expansion program occurred during the 1960's. Essentially the same number of people are still used in the maintenance operation for the University for 44 buildings as previously were used for 10 buildings.

Prior to obtaining the Robertshaw system, a Simplex central start/stop control system was installed by the University and

worked effectively until installation of the EMCS was complete.

Regarding the EMCS system, flexibility in the number of start-stop schedules is of primary importance. Currently 250 different start-stop schedules are being used on the Robertshaw system and 50 more are in the process of being added. Approximately 400 points have been added by the College to the system since its original purchase. Spare points in existing field panels were used to add those points. Cards in the field panels are repaired by swapping out from an in-house stock when the card goes bad. They are then shipped back to Robertshaw for repair. The maximum cost to repair a card has been \$50.00. Robertshaw cards vary in the number of points per card, there are 4 start-stop points per card, 8 status points on a status card, etc. The Robertshaw system does not have a duty cycle program as such, although the same effect is attained by adjusting the demand limiting program. The total cost of the system has been less than \$1,000,000 over ten years. Approximately \$750,000 of that was for the Robertshaw system, the other \$250,000 was used for local start-stop controls and the Simplex system.

The Robertshaw system console is manned from 7:00 in the morning until 4:30 in the evening. During nighttime operation an alarm printer at the Boiler Plant is switched on. The Boiler Plant is manned 24 hours a day. The remote alarm printer was originally installed in the Security Office, but was later moved to the Boiler Plant. The Security Office was found to be unsatisfactory due to high turnover of the students manning the night security desk.

The operator of the Robertshaw system is the highest paid and most knowledgeable of his group. He supervises the people who maintain the Robertshaw system and the local HVAC controls. Use of the highest quality people on the system is recommended. Also, other people within the maintenance and operations organization must be informed of the system capabilities and operations.

The Physical Plant Department is broken into a Maintenance Division which handles all equipment maintenance, excluding controls, and an Operations Department which handles all central control, steam plant, and building control systems. The Operations Department is responsible for operating the equipment and systems on the Campus, while the Maintenance Department is strictly responsible for repairing them.

An energy conservation program package was included as an additive alternate in the original bid for the system, however, its price was approximately \$350,000. The College elected only to purchase the basic EMCS software package and

not the more advanced energy conservation package. By having highly skilled operators they were able to effectively achieve the same results.

An important factor in system effectiveness is the condition of the local controls. For all buildings on the Campus the local controls have essentially been replaced within the last ten years as part of the operation's central control system.

The original Robertshaw system did include metering, however, it did not operate appropriately. The condensate and electrical meters are read each month, manually, in lieu of centrally. The condensate meters used were Badger ER Series with pulse transmitter. The Badger meters were located downstream of the condensate pumps. Steam was metered with orifice plates and Bailey meters with pulse counters off of integrators in the Bailey meters. The primary problem with the steam meters was the turn-down ratio of the meters. Three DP cells were used with different ranges to attempt to obtain greater turn-down ratios. This approach had limited success. Electrical meters used were General Electric D51 meters, L.E.D. type with magnetic push/pull output (low drag). These meters were successful, but the system has problems collecting the information.

The cost of the Robertshaw annual maintenance contract is \$14,400. The central hardware, plus transmission cables out to repeater stations are serviced under a maintenance contract by Robertshaw. All field panels, sensors, and controls are maintained by the University personnel.

The main disadvantage with the Robertshaw system is the lack of redundancy. If the central computer goes down the power system is inoperable. The worst problem that has been encountered was due to a disk failure during one summer when the system was down several weeks at a time waiting on repair of this single component.

It was highly recommended that a system be no larger than a single operator can comprehend and handle. The 1,900 points of this system is approximately the maximum an operator can work with. If a larger system is necessary, then it should be broken down among several consoles with operators at each console responsible only for their specific areas. Operator interest is of maximum importance to a successful system.

It is important to have reports to the operator which are meaningful in his operations. In other words, a display of all space temperatures can be used to compare the operation of buildings at one easy and quick turn. A similar example would

be to display all supply air temperatures to see if any systems are at great variation with the general trend. During the first hour of operation in the morning the operator checks to see what was last on the alarm printout. He reviews all alarms. The operator also checks to see that a proper system status is present, in other words: the date; the day of week; and the outside temperature are all correct or reasonable. After reviewing the alarms, the operator looks at certain critical readings such as space temperatures throughout the Campus. Once these basics have been accomplished, the operator then sets upon the task of shutting off the systems which have been automatically started by the time program, based on space temperature or outside temperature, or simply his feel for the system operation. After shutting down the systems, he reviews alarms and prepares maintenance shop orders for investigation.

It was recommended that additional resistance temperature detectors be included for diagnostic purposes. This is extremely important, particularly as it relates to space temperatures.

One of the systems that is controlled by the Robertshaw system is outside lighting. Emergency backup is also provided for this outside lighting control. The primary factor in having a successful system is having equipment that is controllable in the field.

SITE VISIT NOTES

BREMERTON NAVY HOSPITAL
BREMERTON, WASHINGTON
OCTOBER 23, 1980

ATTENDEES:

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Dan Kaiser	WESTNAVFAC	859-7448(A)
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H. Roger Frauenfelder	ROICC NW Area	(8)439-2600
Pete Walmsley	OICC Trident	(8)860-2341
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Sidney Grant	WESTNAVFAC	Com.-(415)877-7391
Samuel Z. Bryson	NAVFACHQ	(8)111-0155
Lee Watson	Newcomb & Boyd	404/352-3930
Gardner Chambliss	Newcomb & Boyd	404/352-3930

The Hospital has two separate central monitoring and control systems. A Honeywell Delta 2000 Energy Managment System controls the building heating and air conditioning systems. A COMPUGARD Fire and Security System provides those functions for the building. The basic hospital construction was accepted in January of 1980. The COMPUGARD Fire and Security System has not yet been accepted. The Delta 2000 Energy Management System is interfaced with the COMPUGARD system where smoke control is involved. The Delta 2000 normally controls air handling systems and outside air and relief dampers. However, during smoke control mode the COMPUGARD system performs that function and overrides control of the air handling systems from the Delta 2000.

The hospital design occurred in approximately 1975 and the contract was awarded in June of 1976. The original completion date for the Hospital was scheduled for December of 1978. the energy management system was specified under the DIVISION 15 MECHANICAL SECTION. The fire and security system was specified under DIVISION 16 ELECTRICAL SECTION. The original intent was to have an integrated system provided by one supplier, however, due to the fact that different sub-contractors were bidding the different sections, two separate systems were provided. There was a significant lack of coordination between COMPUGARD and Honeywell.

The specifications included a ten day acceptance test. The specs were not adequately explicit on the graphics to be included in the system.

The A&E was not involved in the construction process on a day-to-day basis. A meeting was held with the A&E every six months with sometimes more frequent meetings with the electrical engineers. The A&E did perform submittal review.

Significant difficulties were encountered in simply getting copies of test procedures from COMPUGARD. COMPUGARD did not have operation or maintenance manuals. When they were required to provide them, a newly hired man was assigned to write the Manual. Many problems were encountered with badly integrated circuit cards. When the COMPUGARD system was down the manual fire alarm lights would not work. The fire alarm system would be completely out of commission.

COMPUGARD uses a Johns-Mansville building in Colorado as an example of what their systems are capable of. They used a Rusco Card Reader System for security in the Hospital.

There have been no significant problems with the Delta 2000. The worst problem was a malfunction of the printer.

The chronology of problems encountered at the Hospital was presented. The COMPUGARD system is finally approaching operational status and the Navy will probably accept it within the next few weeks. This has occurred after great difficulty. During some system failures manual fire watches have had to be implemented because of the lack of reliability of the COMPUGARD system.

SITE VISIT NOTES

PUGET SOUND NAVAL SHIPYARD
BREMERTON, WASHINGTON
OCTOBER 23, 1980

ATTENDEES:

Mark Robison	Wood/Harbinger
Lee Watson	Newcomb & Boyd
Gardner Chambliss	Newcomb & Boyd
Steve Bruning	Newcomb & Boyd
Sam Bryson	NAVFAC HQ.
George Novey	LANTNAVFAC
James E. Sura	Pudget Sound Naval Shipyard

Puget Sound Shipyard EMCS was provided by HSQ Technology of South San Francisco. The system received final acceptance on October 22, 1980. The system includes 306 points for HVAC control.

The central hardware configuration is based on the Tri Services Guide Spec and includes a PDP11/34 central control unit with 112 K bytes of memory. A PDP11/03 is used for the central communications controller. An Intercolor colorgraphic CRT with light pen is used as the primary operator terminal. Two disk drives are provided. The first disk drive includes the basic system operations software. The second drive contains the graphics data. As a result of the small quantity of memory provided with the central control unit, the response time of the graphics display was very slow.

The communications system consisted of Government furnished telephone circuits. All circuits from field interface devices were four-wire circuits. These were bridged at the telephone exchange building into the four channels (each two pair) from the telephone exchange back to the master control room. There are a total of 17 field interface devices serving 29 buildings. All field sensing runs are under 2,000 feet in length. 500 ohm nickel RTD's were used for temperature sensing. Most of them were installed in a two-wire configuration. Where long wiring runs were involved three or four-wire configurations were included.

From an operation standpoint, two people in the Maintenance Shops have been designated to assist in getting the system up and running, these include an Electrician Training Leader and a Journeyman Electrician. Another mechanic will also be trained on the system. The system will not normally be manned. It will be checked each morning and the degree of use will depend on the season and the systems involved. They will use the system for a period of time before deciding exactly

how best to man the system. If it is proven from experience that the system requires manning on a full time basis, then a person will be assigned. Mr. Sura is the Energy Conservation Engineer for the Shipyard and is the person in charge of the EMCS.

The Shipyard had an existing Powers EMCS which was located in the Water Treatment Plant. Some of the Powers field equipment was reused in the HSQ system.

HSQ uses software from EMS on a licensed basis.

The original Powers EMCS was controlled by the Utilities Division. It was ignored. The new EMCS is assigned to the Maintenance Shop and is under the direction of the Energy Conservation Engineer of the Public Works Department. The system appears to be conscientiously used and should become a useful tool in the operation of the Shipyard. It was noted that this is, if not the first, one of the first Tri Service Guide Spec systems that has been put into operation.

The 30 day acceptance test for the system was started in July and finished in August. The original completion date for the project was April of 1980. All punch list items were completed and the Contractor left the job entirely on October 23, 1980.

Warranty itmes concerning the software, communications controller, and wire splicing of field devices have occured and are being fixed by the contractor.

SITE VISIT NOTES

HONEYWELL, INC.
ARLINGTON HEIGHTS, ILLINOIS
JANUARY 26, 1981

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Norman Stones	Trident East	(912)697-2341
Harris Bynum	Honeywell Atlanta	
Bill Newcombe	Honeywell	
Larry Dressel	Honeywell	
Dr. Gideon Shavit	Honeywell	
Doyle Adams	Honeywell	
Roger Feulner	Honeywell	
Don McNalley	Honeywell	
Jay Pelkey	Honeywell	
Jay Dowdle	Honeywell	

Communication system discussion opened the meeting. Discussion centered around the use of fiber optics for communications links. The use of a fusion splicer for optic fiber splicing was discussed. It was suggested a laboratory be set up on Base where a technician could practice fusion splicing before having to go to the field to perform a repair with the splicer. Use of the splicer requires skill and confidence. Locating a break in a fiber optic link is difficult. It was suggested that a test wire be bound in the enclosure with a fiber so that the wire would break before the fiber actually breaks. Conventional means of locating cable breaks could then be utilized. Belden has been very cooperative in the past in constructing special cables, including a mix of fiber and hard wire. All splices in manholes should be made with a minimum of 6 to 10 feet of slack in the manhole for use in future repairs and resplicing. Mechanical connectors are better than fusion splicing for repair and check out of sections, however, they have greater loss than fusion splices. The Deutch connector is a high quality mechanical connector. The specifications should state that each connection should have a maximum loss and the supplier must certify a test of each connector to insure the loss is not greater than specified. If a laser is used to drive the fiber optic system, those manufactured by General Optonics in South Plainfield, N.J., area code 201-753-6700 (Dr. C. J. Wang) are of extremely high quality. Expected life of 100,000 hours are being obtained with these lasers.

Review of Honeywell Delta 5600 Series EMCS

Larry Dressel presented an overview of the Honeywell Delta 5600 system. See the attached literature. Honeywell has approximately twenty-seven 5600 level systems sold with 40-50% of those being military systems. In terms of system response time, a change of state reporting should occur in 4 to 8 seconds, however, response to operator action should occur in no more than 2 seconds such that operator interaction can proceed on a reasonable basis. It is very important for the operator not to have to wait on the system to respond to him. Honeywell has placed a heavy emphasis on development of their field interface device (560) application software. The 560 FID cannot be purchased as a stand alone device. The 560 requires a Level 6 master computer for programming purposes. Honeywell reviewed the need for detailed quality documentation on software and provided examples of the documentation they are preparing on the 5600 System.

Specification Discussion

Harris Bynum presented Honeywell's view of military EMCS specifications and procurement. See the attached handout for a copy of the presentation.

SITE VISIT NOTES

BROWN BOVERI COMPUGUARD CORPORATION
CHICAGO, ILLINOIS
JANUARY 27, 1981

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Norman Stones	Trident East	(912)697-2341
Ron Luque	Brown Boveri Comp.	(412)622-6200
Carlo Gorla	Brown Boveri Comp.	(412)622-6200

Compugard demonstrated the operation of their system at their display in the ASHRAE Exhibition at McCormick Place. The field interface devices include three types of cards: 1) CPU card; 2) binary input card (BIN); 3) a universal (UNI) card. The basic operating system in the FID is included in PROM. Parameters for use in that operating system are downloaded from the central. What Compugard calls micro-procedures are burned into the PROM and building of micro-procedures is downloaded from the central. Macro-procedures consist of sequences of the micro-procedures. There is no downloading of 6502 code. RS-422 is used for communications between the CPU card and function cards. Modifications are currently underway to also allow RS-232 communications. Either RS-422 or RS-232 can be used for communication from the FID CPU to the master control room.

The software capabilities of the system were demonstrated, including priority execution, point display using "wild card" option, point display definition of function keys and display of graphics.

Meeting reconvened at McCormick Inn to discuss Compugard activity in EMCS area. The following items were discussed:

1. No manufacturer's EMCS could comply with the Tri-Service Guide Spec when it was originally released. As the spec has been revised, redesign has been necessary for each manufacturer to meet the new version of the Guide Spec.
2. Since no system met the Guide Spec when it was released, all manufacturers were required to develop their systems based on whatever experience they had in the past. Generally, the forecasts of development time have been off by at least 200%. Instead of taking one year for

system development, it is taking approximately three years.

3. Because of delays in development, early versions of hardware and software have been released to the field before they have really been tested and are ready for field installation. This resulted in bad field experiences that would not have occurred if a normal product development scenario had been followed instead of development being instigated by each new version of the spec.
4. In the evolution, of the Guide Spec, many comments from the manufacturers were not incorporated in time to affect projects being bid. Therefore, requirements in the Guide Spec, which were later changed, are included in current contract specifications. This has resulted in difficulty for manufacturers trying to meet requirements that are now no longer valid.
5. The delivery times called for in contract specifications did not allow time for system development and field testing. The delivery times called for were reasonable for off-the-shelf, fully tested systems which were not available for Tri-Service Specification requirements.
6. The Tri-Service Specification called for industry to develop in a direction that it would have gone eventually. The large quantity of business generated by this specification pushed industry in that direction earlier than it would have gone otherwise.
7. Compugard systems are currently being installed at the University of Delaware, the University of Maryland, and the University of Texas.
8. Compugard feels in six to eight months EMOS products will mature enough to eliminate many of the problems that have been encountered in the past.
9. One Compugard system currently on line is located at the Naval Ocean System Center in San Diego. Completion of minor documentation is all that remains before turning over of the system to the Owner.
10. Compugard has experienced difficulty in the manufacturing of cards and is currently solving those problems. At one time substantial difficulty was experienced in obtaining micro-processor chips. That problem is now no longer a factor. The time to test and check out cards is significant, although using a new automated Hewlett-Packard card tester will significantly decrease that time. In

the software development area, Compugard released their LX-20 EMCS software before it was ready. Field people on individual projects modified and corrected problems as they were encountered. Compugard is now in the process of consolidating all those modifications and corrections to come up with a debugged and complete LX-20 software package.

11. Compugard recently was awarded an \$11,000,000 EMCS project from the Tennessee Valley Authority.
12. After function cards have been checked by Quality Control, Compugard systems personnel require approximately one hour per card to do systems integration checkout before shipping to the field.
13. The average Compugard technician in the field commissions between 70 and 100 points per week.
14. Bremerton Naval Regional Medical Center, which has a Compugard fire and security system, is supposed to be operational with only two major failures since November, 1980.
15. Compugard will provide a complete list of Compugard projects.
16. It is imperative to have a system operator who understands the goal of saving energy. A person in charge of the system must have both engineering and management training for it to be a success.
17. The Colorado State Hospital is an excellent example of the best use of an EMCS for energy conservation.
18. The long response time for systems in the field was discussed. The Orlando Naval Regional Medical Center which recently took 6 minutes to perform smoke control sequences was discussed. Compugard is currently looking at hardware and software mechanisms to speed up system response time.
19. It is unknown whether or not Compugard will furnish updated software as it is debugged on their old completed projects.
20. Compugard will provide information on their card production rates versus the number of cards sold on their projects.
21. Caution should be used in introducing changes to the Guide Specifications. Much has been invested in develop-

ing a system to meet the Tri-Service Spec and massive changes at this point in time would cause all suppliers to return to a development mode instead of production mode.

22. The use of a pre-qualification process is the only way to avoid repeating the same problems with EMCS suppliers that have been encountered over the past three years. Any supplier will take at least three years to fully develop their system. If a supplier who is at the same point in development as Compugard was three years ago is allowed to bid on a project, then they will have exactly the same problems that have been encountered on current projects.
23. One means to accomplish pre-qualification would be to use a two-step procurement process including an experience clause and a requirement to submit complete documentation on the system as proof that it is fully developed.
24. The Army version of the Tri-Service Specification that is currently being reviewed has not changed enough to cause major developmental problems for Compugard.
25. In terms of problems encountered in the field, the main area of concern is the condition of the existing controls. Compugard feels that the specification adequately covers the requirements in that area. The most frequent problem is the capability of the on-site maintenance organization to effect the repairs called for in a timely manner.
26. Ron Luque will provide additional information on Compugard's experience with various communications networks.
27. Compugard has performed several factory tests for military EMCS which have been allowed to pass, but only because the people viewing the test were not knowledgeable in the specification requirements. Compugard is now far enough along with software development that they feel they will be able to pass a complete factory test shortly.
28. Discussion of competitive expansion. A recent expansion of an EMCS at Reese AFB could be bid on a competitive basis because a complete protocol manual was furnished, including the data base structure as a part of the contract documents. An interface software structure could then be written to provide for competitive expansion. However, it is important to note that this interface software will cost between \$50,000 and \$100,000 and that an expansion where only a few FID's are being added cannot justify that level of expense.

29. An alternate means of system expansion would be for the Government to purchase FID's and function cards from the original system supplier at list price and either install them themselves or subcontract the installation. All field work could be bid on a competitive basis. This was not possible in the past because even though the Government could purchase the hardware on a list price basis, they did not have the means of adding to the system data base.
30. As part of the basic contract bids for a project, list prices from all manufacturers could be requested to be used for future expansion.
31. Western Michigan University used a detailed unit price schedule approach where the final quantity of different types of points was not actually defined in the contract.
32. There is a need to determine means of coordinating and performing training and on-going monitoring of system performance. Systems are currently not far enough along to evaluate the effectiveness of the training or the operation. One possibility would be to jointly sponsor the preparation of video tapes or other aids for use by the manufacturers and government personnel.
33. A particular area of training not currently addressed is how to use an EMCS effectively to accomplish energy savings. Most training is oriented toward mere operation of the hardware and software and preventive maintenance. Additional training is needed to teach people how to use the systems efficiently and how to obtain energy savings through strategic use of the systems.

SITE VISIT NOTES

RAYTHEON SERVICE COMPANY
BURLINGTON, MASSACHUSETTS
JANUARY 28, 1981

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Ted Czernik	Raytheon	(617)972-9300
Owen Duggan	Raytheon	(617)972-9300
Jim Smith	Raytheon	(617)972-9300

The following items were discussed:

1. Raytheon is currently only in the large system EMCS business as defined in the Tri-Service Guide Specifications. These are primarily multi-building facilities.
2. Raytheon pursues Government EMCS activity as advertised in the Commerce Business Daily.
3. Raytheon currently has nine Military Bases under EMCS contract and one large commercial project and contract.
4. The largest Raytheon EMCS project is the Public Works Center, Norfolk, Va.
5. Raytheon Service Company's EMCS Division has been in business approximately three years.
6. The first Raytheon system to come on line will be at Fort Bragg, N.C.
7. Raytheon EMCS projects range from \$750,000 up to \$4,000,000.
8. Fort Myer, Va. is the most recently awarded contract for Raytheon EMCS.
9. The smallest system Raytheon is installing has approximately 900 points. The largest Raytheon EMCS has approximately 7,000 points at PWC, Norfolk.
10. The Fort Bragg EMCS time schedule has extended beyond the original completion date.

11. All other Raytheon projects are currently on schedule as the current contracts stand.
12. Several of the contracts have been extended or delayed due to inconsistencies in field conditions.
13. None of the projects in which Raytheon is involved have Title II A/E services.
14. Raytheon feels there is no need for A/E Title II services if EMCS continues to be procured in a brick and mortar construction type format.
15. The EMCS projects essentially turn out to be design/build projects, even though they are procured under construction type procurement. This is due to an inadequacy of definition in the field design.
16. A substantial amount of time is invested on the part of Raytheon in verifying existing field conditions.
17. Raytheon has encountered difficulties in the early stages of projects because EMCS construction work cannot start immediately as the local inspectors are accustomed to experiencing.
18. Bid cycle times for EMCS projects have been too short. Additional time is needed for the bidding process. Shop drawing preparation time is too short also.
19. On only one project has Raytheon found good existing equipment information available from the Base personnel, that was at Dam Neck, Va. Naval Base.
20. In terms of procurement methods, most of the Raytheon projects have been one step invitation for bid. Only one of their projects was a two step procurement. The basic assumption behind one step procurement is that all bidders are equally qualified. That assumption is basically incorrect. A two step process seems more meaningful as a means of procurement. Raytheon feels EMCS should not be purchased through an advertised procurement and instead should use a weapon system and electronics type of procurement. This method is a negotiated procurement method with technical management and cost evaluation factors included in the selection of the contractor.
21. On all of their projects, Raytheon has been the prime contractor. The actual construction part of their projects has been less than 30% of the total contract price.

22. If a negotiated procurement method was used, the weighting factors for evaluating suppliers could vary from Base to Base. Factors would have to be defined in RFP and be the same for all bidders.
23. The purchase of an EMCS as a brick and mortar construction project is simply inappropriate. EMCS are complex electronic systems and not off-the-shelf universally available devices. Another approach would be to procure systems on a system development basis similar to flyoffs used for aircraft procurement.
24. In two to three years most of the systems currently under contract will be fully operational and a set of qualified bidders will be available at that time. However, no means are currently being used in EMCS procurement to prevent unqualified bidders from low bidding projects and using them for development financing.
25. The term used in electronic systems procurement is "negotiated two step".
26. Many difficulties have been encountered in the field. These include building occupant resistance, security requirements not identified in specifications, occupants not informed of what is going on, and difficulties in getting outages of utilities. All these things cause delays in the process of construction.
27. Another area of difficulty is in developing quality documentation. The specifications do not define who will use and maintain the EMCS, thus the level and quality of documentation which is written for those people is not defined. If the people using and maintaining the EMCS are highly technical, these documents should be written one way, versus if the people are not as technical, the documentation should be written in a different manner. The type of people for which the documentation should be written should be defined. The EMCS should be used as a management tool with management level people involved in its operation.
28. Raytheon is currently performing an operations survey of EMCS sites around the country. The survey is finding approximately 80% of EMCS sites are using high school graduate level operators with zero to one year experience.
29. Where the specifications call for the updating of existing control diagrams, those diagrams cannot be updated if they do not exist. The scope of the contract is not sufficient for the contractors to create control diagrams from field inspection.

30. Training requirements in the guide specifications are not adequate. Additional training is needed, particularly for a higher level systems analyst person in system level capabilities.
31. On most sites no one is assigned to the system from the user's standpoint until time for system acceptance. This results in much wasted effort and poor performance of the systems. There is a need for user involvement from the design stage through the total procurement and construction process.
32. In terms of EMCS expansions, it is felt that the real problem is not in the hardware interfaces, but in the software, including protocols, data base structures, etc.
33. The Tri-Service Specification software section is not adequate and more detailed sequences of operation for each piece of equipment must be specified.
34. In terms of expansion, it is critical to decide prior to the installation of the first increment of the EMCS what the overall strategy is to be over the entire life of the system.
35. Field interface devices (FID) should not evolve into overly powerful devices. Don't make the FID too complex. Don't continually change the specifications to modify functions of the FID versus the master control room equipment because it causes massive changes in software configuration and thus will be very difficult to get out of the development phase and into the manufacturing phase.
36. System expansion basically has to proceed on a proprietary basis until the capacity of the original system is exceeded. Then simply purchase an additional system to fulfill those needs.
37. The strategy for performing maintenance on the EMCS must be identified early in the project.
38. In regard to the use of direct digital control, the primary problem is not hardware, but is in the development of the software to perform the DDC functions.

SITE VISIT NOTES

DIGITAL EQUIPMENT MANUFACTURING PLANT/MCC POWERS EMCS
BOSTON, MASSACHUSETTS
JANUARY 28, 1981

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Michael McCown	MCC Powers	(617)890-9540

The following items were discussed:

1. The EMCS at this facility was provided by MCC Powers. The building is a manufacturing plant for large DEC computer systems. The system configuration includes a DEC PDP11/34 with 128K words (256K Bytes). The system includes a color CRT (Intelligent Systems Corp.), a VT100 black and white CRT, a DECWRITER alarm printer, and two 5 megabyte disk drives. A printer without keyboard is also included at the security desk for alarms during unmanned operations. The system will operate with only one of the two disk drives operational.
2. The field panels are called remote processing units by Powers. They include 8 slots for function cards, each card can handle up to 16 different types of points.
3. The system uses the RSX11M operating system. The Powers Kernal software provides the basic EMCS operating software. In addition to the Kernal software, option packages are available from Powers. The system scanning uses a "report by exception" method. Parameters for the "report by exception" are downline loaded from the central to the field panels. The system will automatically restart after a power failure, using an external uninterruptable clock. There are no stand alone functions in the remote processing units. The system can handle up to six independent operator consoles. For each field point in the system, the consoles which are applicable to that point may be defined. Custom report generator software is currently being developed by Powers.
4. The system includes an equation processor which provides arithmetic, logical, and timing functions for control of field devices based on field input. It provides for

event initiated sequences. The Powers duty cycle and demand limiting packages are actually written using the equation processor.

5. The system colorgraphics capability was demonstrated. The system can be operated strictly through the black and white CRT with the color CRT used only as a graphics display unit. The software for the system can be run on any computer using the RSX11M operating system, including DEC PDP11/44's, 11/60's, and 11/70's.
6. The basic system can handle up to 1,400 points using a single 5 megabyte disk and a DEC 11/34 processor. The system can handle many more points than that with a larger disc and faster processor. The system installed at this facility has 245 physical points in the field. The second disk drive is used for software backup purposes and as a standby. It is not used as part of the on-line system.
7. The system at this facility has been operational for one year with only one period of down time. This down time was caused by a fork lift severing the communication line. The Powers system replaced an energy management system originally manufactured by DEC. DEC later discontinued their involvement in this field. All communications are over dedicated communication links. There are a total of 14 field panels included in the system controlling air handling units, chillers, and other HVAC devices.
8. Pulse accumulation is accomplished on the system simply using any digital input point.
9. Powers recommends anywhere from two days to three weeks of operator training, depending on the quality of the operator. Engineering level personnel are needed in order to really get good performance out of the system.
10. The system installed at this facility was the first of this model from Powers. No design or bidding process was used. The system was directly purchased from Powers by DEC. The system includes a dial-in automatic answer modem for trouble shooting from the Powers factory. The contract for the system was awarded in February of '79, the hardware was installed in April of '79, and it was fully operational with software in January of '80. Powers is currently installing 250 point systems in a total construction time of six months.
11. Powers has backordered a large quantity of DEC hardware so they have not encountered DEC related delays in their deliveries.

12. The system is operated one shift per day with the remote printer at the security desk for overnight operation. They have not had any field device failures in the past four months.
13. All temperature sensors are 2,000 ohm RTD's.
14. Powers currently has between 12 and 14 operable systems of this generation. They currently have 40 to 50 projects under construction. Powers announced their offering of direct digital control capability at the recent ASHRAE Exhibition. The new system includes local stand alone direct digital control capability. Their current system does not offer central communications control failover, but they have not encountered problems with their central equipment and don't feel it is necessary.
15. Powers' experience on system cost has shown that for systems with over 150 points an approximate total installed cost of \$750 per point can be expected. The central hardware cost using a DEC 11/23 computer with two disk drives is approximately \$40,000. The cost for a field interface device, not including the function cards, is between \$1,500 and \$2,000. The function cards with terminal strips for installation in the FIDS cost from \$200 to \$300 per card. The largest project Powers currently has underway is the Crocker Bank in San Francisco which is between \$2,000,000 and \$3,000,000. Another large system is operating at the Chicago Tribune building and has approximately 1,400 points.
16. Powers feels, using their newly released direct digital control system, that they could handle a project of Kings Bay size.
17. Experience and point checkouts has shown time required for a technician is approximately 10 to 15 minutes per point in the field.
18. Powers has applied for Underwriters Laboratory fire alarm listing.
19. All Kernal and optional application software packages are written in Fortran.
20. To inquire about Powers' interest in Tri-Service Guide Spec projects we should contact Rick LeBlanc with Powers Northbrook, Ill. factory. His phone number is (312)272-9555.

SITE VISIT NOTES

NEWPORT NAVAL TRAINING CENTER
NEWPORT, RHODE ISLAND
JANUARY 29, 1981

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Norman Stones	Trident East	(912)697-2341
Jim Brown	Northern Div NAVFAC	
John Beuevera	NETC Head Electrical Engineering Branch	
Harold Belson	NETC Director, Engineering Division	
John Capececiras	NETC AUMS Operator	

The following items were discussed in a review of the system with Jim Brown:

1. The system includes 12 buildings of approximately 400 points. Its primary function is to perform night setback operation of steam supply valves. The CCU is an Interdata 7/32 with 256 K bytes of main memory. The system includes a 50 megabyte Trident disk drive and a 10 megabyte (5 fixed plus 5 removable) cartridge drive. The system can be expanded up to 256 points per FID and up to 55 FID's can be added on the system. An auto-answer dial-in modem is currently being added to the system. The 12 field interface devices (FID's) are connected via separate four-wire phone line circuits back to the central control room. This is the maximum number of FID's the existing communications concentrator can handle. A change to a two-wire phone line configuration is currently being considered such that the concentrator can handle 24 FID's instead of only 12.
2. The system was supplied by a prime electrical contractor with Radix II as subcontractor providing system equipment. The original project bid anticipated using Compugard equipment, but Compugard was unresponsive and the prime contractor switched to Radix.
3. The original project bid price was \$270,000 and is currently up to \$315,000, including change orders. No software was included in the original system purchase. Software cost was estimated at \$15,000.

4. The original project specifications were based on a Honeywell Delta 2000, but in the process this was changed to an early version of the Tri-Service Guide Specification. The software requirements the Guide Specification were removed because GSA EMCS software development was to be used for this system. The GSA software is yet to be accepted by GSA from the contractor.
5. A remote CRT and 120 character per second printer is located in the Design Division offices. These are currently being used for design programs and not EMCS applications. The operator's CRT and a 30 character per second alarm printer are in the operator area. No graphics are included on the system. Engineering programs may be run simultaneously with the EMCS operation.
7. The 50 megabyte Trident disk drive was added as a change order to the contract. A change order is currently underway to provide for further operator documentation and a series of operator logs. This change order is for approximately \$30,000. Commander Dalke from Newport is the Contracting Officer.
8. The Interdata 7/32 talks to a Radix concentrator which talks to modems which are connected to phone lines leased from the Bell system. There are no stand alone functions included in the field interface devices (FID). Automatic changeover to local controls on FID failure is included in FID's. The system reports on a purely scanning basis. No "report by exception" is included in the system data gathering method. No redundancy is provided in the system in case of component failure.
8. The Radix data concentrator does all scanning of the field points. The CCU then addresses the concentrator once every 30 seconds to update its data base from the most recent information gathered by the concentrator. On operator inquiry, the CCU reads the point status from the data base and not directly from the field. All data in the data base is time and date stamped.
9. The system has very little time as an operational EMCS. The system has been used as an EMCS, at most, only a few days at a time. A full time operator is not assigned to the system. It is expected that in the first three to six months the operator or the person assigned would be involved approximately 30 hours per week. After that, it is expected that approximately 20 hours per week would be dedicated to the system, including field swap out of boards and devices that have gone bad. The designated person has HVAC experience. Radix strongly recommends training an HVAC man to use the computer rather than

training a computer person to control HVAC systems. Jim Brown feels that the problems encountered on the system have been due to "inevitable birthing pains of EMCS" that must be worked out in the field.

Meeting was reconvened in a conference room including Newport Station personnel, but not including Jim Brown of NORTHDIV or Radix personnel.

10. Station personnel reviewed the history of the project. The original project scope included 20 buildings and anticipated using a Honeywell Delta 2000. At the final design stage NORTHDIV chose to change to Tri-Service Guide Specifications without including the software section. The software was excluded based on anticipation of the ability to provide government furnished software within six months after contract award. The contract was awarded to an electrical contractor with Compugard as the system supplier subcontractor. Compugard wanted to be relieved of the project, although there is no clear indication of why they wanted out. It was understood that Jim Brown suggested Radix as an alternate supplier to the electrical contractor. The Interdata computer was delivered in July of 1978. The system crashed after two weeks of operation of the Interdata machine and sat with no change for the next seven months. The EMCS software was not operable at that time. No government furnished software has ever arrived. It is not clear who actually owns the software that is currently in the system. In the Spring of 1979 the original EMCS software was installed on the machine by Radix. The original software was too big for the core memory provided on the machine. Radix spent six to ten weeks on site trying to shoehorn the software into the machine. Additional memory had to be added to the machine in order to handle the software and was done at government expense. In some meetings, Radix has indicated that they would remove their software from the machine if they were pushed too hard. One of the primary difficulties has been that there is no direct relationship between the government and Radix, since Radix is a subcontractor and not the prime contractor. The electrical contractor that is the prime contractor on the project is regarded by Station personnel as being excellent and has been very cooperative throughout the entire project. The system was accepted by the government in September of 1979 because the contract at that time had been fulfilled. The contract called only for the delivery of hardware, with no software, and thus no operation could be proven. There were no reliability requirements in the specifications and in several instances the specifications were essentially ignored. In several instances the government simply took Radix' word

that what was being provided was equal to or better than the specifications. A seven day acceptance test was included in the specifications. The test was unenforceable since no software was provided and the system hardware simply had to be present to pass the test. A test program was to be written by Jim Brown for testing operation of the system, but was never provided.

11. Night setback, or any other applications functions, have never operated on the system automatically. The night setback software that is apparently being provided operates on a Basewide basis and not on a building by building basis, according to Station personnel.
12. The time to scan all field points from beginning to end by the concentrator is approximately 20 minutes.
13. The original training called for in the specifications could not be provided since the system was not operational. Also, no documentation on system operation has been provided, so operators could not study and prepare for operation. The Station feels the operators should not have to be trained to actually program a system, but only to operate it and enter the proper parameters. The system reliability was discussed. The field devices have had extremely good reliability. The FID's have had very poor reliability. FID function cards were too large to fit in the card cages so the card cages were removed and the cards are now supported by a field rigged support. Cards often are loose and don't fit properly into their interface slots. Many FID power supply failures have been encountered. Function boards provided are of poor quality and many are wire wrapped breadboard type construction instead of manufactured construction.
14. Problems have been encountered with the central equipment reliability. Non-Interdata memory and controllers have been used on the system, in addition to other peripherals such as disk drives, which were not provided by Interdata. Interdata was informally asked to provide a service contract for the Station, but declined to provide one because of the large quantity of non-Interdata devices. The Station has been unable to find anyone to service some parts of the system. On a disk controller failure, the disk controller had to be sent back to the manufacturer for repair and the system was not operational while that was proceeding. During the one year warranty after acceptance, however, no major central equipment problems were encountered.
15. No PROM burner was provided for the system. No documentation has been provided on FID software and no means has been provided to change or modify the FID software.

16. Plans for expansion of the system have been on the shelf now for several months awaiting operation of the initial increment. It is not clear what will be necessary to get the system fully operational.
17. No slowdown of the EMCS has been experienced while background functions have been performed.
18. During one of the brief periods when the system was operational, erratic FID performance actually caused a building to freeze up over a weekend, even though the central was down and the FID was supposed to revert to normal local controls.
19. The system was purchased using one-step invitation for bid procedure. It's not clear whether a factory test was required in the original specification and since no software was included in the project, a factory test could not be performed.
20. Problems were encountered because the ROICC was not technically trained to supervise construction of the project. The ROICC used Jim Brown, of Northern Division, as a technical resource.
21. The Station was not aware of any shop drawings ever furnished by Radix on the system.
22. The beneficial occupancy date for the system was 1979 with an outstanding punch list. The contract is still not closed due to minor items still remaining on that punch list. The prime contractor is still very cooperative with Station personnel.
23. The specifications did not include a requirement for CCC failover.
24. The problem in the FID's that caused building freezeup has still not been identified to Station personnel.
25. Station personnel requests a copy of any report written as a result of this interview.

The meeting was reconvened later with Jim Brown of Northern Division present, but without Newport Naval Station personnel present. The following items were discussed:

26. Jim Brown suggested the possibility of looking at a Radix system currently installed at Lord & Taylor Department Stores as an example of operational systems.

27. The contract for the Newport EMCS project was awarded in late 1978.
28. The software currently being purchased by GSA for government use requires some minimum applications functions, but not a complete working applications section. The software currently installed on the Newport EMCS is actually more than what is required under the GSA contract for which Radix is furnishing the software. The additions to the GSA software will be provided free of charge to Newport from Radix. A change order for \$15,000 to Radix for the loading of the system data base is anticipated, or has already been entered into.
29. The system is now out of the warranty period. Jim Brown is currently making changes in the FID function cards to try to prevent the latch-up that caused buildings to freeze up earlier in the year.
30. The FID's do not provide distributed processing, but that capability could be added by simply changing PROM software.
31. Calculations by Jim Brown show a scan time of all points by the concentrator of 3-1/2 minutes.
32. One difficulty encountered is that the documentation of the problems that have occurred has not been adequate to trouble shoot what the problems are a result of. The system has never been fully operational. Jim Brown did not recall whether a 30 day test was included in the specifications. No operational acceptance test was performed other than the single day instantaneous check-out of the hardware that was provided for under this contract.
33. A test program that was to be provided by Jim Brown was not provided since Radix installed their software on the system instead and thus no test program was required.
34. The Crane Indiana system was also procured without software and currently is operating with only the test program. Northern Division is using A/E services contract to procure the central software. The contract for that procurement has been awarded to Able/Radix who provided the hardware contract. A proposal has not yet been received from Able/Radix for the software, but it is supposed to be mailed within the next few days. The government estimate for the software cost alone is approximately \$30,000. At Crane the hardware contract price was approximately \$360,000 for a total of 16 buildings. The hardware was procured under straight invitation for

bid and software is being procured as part of an A/E services contract.

35. The objective for splitting software from hardware is such that Northern Division will end up with the same EMCS software at all of the Bases under their jurisdiction. Regarding government furnished software, the GSA contract has never been completed. When it is completed, it will not include sufficient software to have an operational system. In attempting to have the same software at all NORTHDIV sites, the objective is to be able to issue the same bug fixes and system modifications, to promote a user's group among all sites, and to provide common operator training for all Northern Division sites.

SITE VISIT NOTES

NAVFAC HEADQUARTERS
ALEXANDRIA, VIRGINIA
FEBRUARY 3, 1981

ENERGY MONITORING & CONTROL SYSTEM SPECIFICATION REVIEW CONFERENCE

The Specification Review Conference was organized in a three day format to provide for presentations by each Engineering Field Division on the first day, with two following days of specification review comments. Sam Bryson of NAVFAC Headquarters hosted the first day of presentations and George Novey of Atlanta Division NAVFAC moderated the specification review comment days. Comments received during this Conference will be incorporated to a consolidated Navy position toward the revision of the Tri-Services Guide Specifications currently being produced by the Corps of Engineers, Huntsville Division. Sam Bryson introduced all participants on the first day. Al Bradford, the head of NAVFAC Headquarters Design Division, provided opening statements regarding EMCS acquisition within the Navy and problems that are currently being encountered.

Bill Gleason of NEESA presented the results of a study his organization has performed of NAVFAC performance in high technology areas. This study included Energy Monitoring and Control Systems. The study took the management approach to the analysis of the problems. Gleason reported, within the Navy, there are nine operational systems, even though fifteen systems have been accepted from a construction standpoint. Thirty-two systems are under construction at this time and twenty-one systems are in the planning and/or design phase. A copy of the report presented by Bill Gleason is attached.

Karlin Canfield of the Navy Civil Engineering Lab presented the Lab's activity in the EMCS area. The Lab is currently working on development of an EMCS simulator for use as a training and selling tool for EMCS. A number of other CEL projects relating to EMCS were reviewed; including the Long Beach Hospital EMCS, metering studies at Point Mugu and Little Creek, and single building controller studies currently underway. The National Bureau of standards is currently studying the sensor section of the EMCS Guide Specs and will be providing input.

Bill Tayler of NAVFAC Headquarters Utilities Division reported on the status of planned EMCS projects. All NAVFAC FY-82 EMCS projects have been deferred. Within the next few weeks a decision will be made on which 3 projects will be funded. One approach being discussed is to include only one project

per Engineering Field Division in FY-83. Questionnaires have been sent out to all Navy activities regarding EMCS procurements. These will be passed on to CEL for compilation.

Joe Watson and George Novey of Atlanta Division NAVFAC presented their organization's viewpoints on EMCS. Their basic philosophy is not to put an EMCS on an HVAC system that is not operational. They have found that a number of HVAC systems on their Bases have not been maintained properly over the years and the controls are inoperable. Their Division has updated Guide Specification 15901 for automatic temperature controls to include field devices such as sensors and their wiring back to a data terminal cabinet. Their feeling is that all field work should be removed from the EMCS Specification and included in the HVAC Specifications. They feel it is important to do detailed design of all field work back to the data terminal cabinet, including all interfaces with existing controls and any upgrading of existing controls that is necessary. In terms of EMCS operational requirements, a brochure developed by the Tactical Air Command which describes personnel requirements for EMCS was presented.

Commander Goins, representing the Chesapeake Division of NAVFAC, presented their experience. The primary area of discussion from Commander Goins regarded contractual tools for construction projects. The procurement methods and contractual methods used for standard brick and mortar construction are very crude and ineffective when dealing with a high technology area such as energy monitoring and control systems.

Jim Brown of Northern Division, NAVFAC, presented their approach to EMCS. Their feeling is that software should be procured separately from the basic hardware procurement for the purpose of standardizing software within their field division sites. They feel this is important to provide common operator training, common debugging, and common operational requirements. Jim reported they are in the process of developing a maintenance manual at their Newport site which will include detailed logs of information that should be recorded on maintenance problems and operator problems for later diagnosis.

Paul Buonaccorsi of NAVFAC Headquarters Office of Counsel discussed legal aspects of the EMCS procurement. The primary area discussed was in regard to software rights and the need to use a formalized approach in obtaining data from the contractor and the definition of the licensing rights which the Government obtains. The attached memo discusses acquisition of technical data and software and the DAR clauses required in the contract.

John Phillips of Western Division NAVFAC presented that organization's experience. An EMCS advisory team has been set up at WESTDIV to improve the overall process of EMCS procurement and operation. The team is composed of people from Utilities Division, Design Division, Construction Division, Contracts Division, and other people as necessary to provide overall input into the EMCS process. Western Division has approximately 20 projects related to EMCS with 15 of those projects procured under ECIP guidance. Three of their projects are currently on line, all three are pre-guide specification projects. Three to four additional systems are at least partially operating. WESTDIV is further along than any other EFD in terms of the number and status of their projects and the areas they are encountering problems in now primarily deal with software licensing and rights in software, as previously discussed by Paul Buonaccorsi. They have also experienced difficulties in their projects being required for small-business-set-aside procurement and the elimination of some qualified bidders as a result of that. In regard to the software licensing, on one project the correct Defense Acquisition Regulation clauses were included, however, a Form 1423 which defines which software those DAR clauses are applicable to was not included in the contract and thus the DAR clauses had no effect.

Ken Tsujioka of Pacific Division NAVFAC presented his experience. They have one project at the Pearl Harbor Naval Base, which is very similar to an EMCS, where a computer system is used for electrical supervisory work. The system construction is completed, however, it has not yet been accepted by the Navy. The primary problem they feel with the system is its extremely slow response time. An EMCS is planned for the Pearl Harbor area feasibility study has been completed, however, the design phase is now on hold awaiting resolution of NAVFAC direction on EMCS. Construction is underway for an EMCS at Naval facilities on Guam with an October 1980 contract award to HSQ Technology for providing the system.

Ed Andrews of Southern Division NAVFAC presented their experience. SOUTHDIV has several sites where EMCS Tri-Service Specifications are going in, including Keesler AFB, Orlando Navy Regional Medical Center, and an installation at Corpus Christi, Texas. In addition, 4 Bases were included in a common purchase package and those systems are being installed by Burns Integrated Systems. SOUTHDIV's experience has been that the biggest problem with EMCS lies in the communication links. They have used dedicated systems, telephone systems, and other configurations and feel strongly that the use of all government furnished telephone lines is a necessity. Dedicated communication systems require a separate maintenance force and are extremely expensive to install. They have had good luck with the use of a multi-point polling broadcast

communications configuration. SOUTHDIV feels more detailed information regarding the existing field conditions has to be shown on the drawings. On the 4 Base project, they required the A/E to list each piece of equipment and nameplate data of that equipment on the drawings. They also feel that the A/E must stay involved throughout the project through acceptance testing. Ed presented examples of similar systems procured in the process control industry and the substantial difference between their approach and the Navy's approach. In that industry, a typical 500 point system costs approximately \$1,500,000. Industrial process controllers were used and a large operating and maintenance staff was planned, including 3 operators per shift, 3 process technicians per shift, 8 electronics technicians per shift, 2 instrument and control engineers, and 2 process programmers. The acquisition method used in the process industry was to actually hire the above listed personnel who, in the Lab, actually did detailed design and construction of the control system, simulated lab operation with it over a 2 year period and, after debugging, disassembled the system, took it to the plant, and installed it.

Pete Walmsley of OICC Trident presented their experience. The Trident system at Sub-Base Bangor as initially installed has never been fully operational and, in fact, much of it is currently being replaced by a follow-on expansion project. At the East Coast Trident Base a study is currently underway regarding EMCS and how to avoid the problems experienced at the Trident West site.

SITE VISIT NOTES

NAVAL AIR REWORK FACILITY
ALAMEDA, CALIFORNIA
FEBRUARY 12, 1981

ATTENDEES:

Norman Stones	OICC TRIDE	(912)697-2341
Jones Tong	NARF ALAMEDA	686-3991
Nick DiMario	WESTDIV	859-7381
Robert Kwan	WESTDIV	859-7435
Vytas Nalis	WESTDIV	859-7381
Mack Herbach	WESTDIV	859-7381
Pete Walmsley	OICC	(912)697-2341
Samuel Z. Bryson, III	NAVFAC HQ.	221-0155
Gardner Chambliss	Newcomb & Boyd	(404)352-3930
Terry H. Kishiyama	PWC SFBAY	864-2263
Joaquin de la Roza	PWC SFBAY	864-2891
Phil Vercelli	NARF ALAMEDA	686-3991

Contract Award Date: June 1978

Contractor: Johnson Control

Number of Points: 500 Points Approximately

Status: Estimate 85% complete

1. Hardware installed and checked out
2. Software delayed

This project was bid as a pre-guide spec job in September 1977. The bid list contained Johnson, Compugard, Radix II and Honeywell. Johnson received this job as a part of a three system buy. They are furnishing an early version of the JC84 Series. The system contains a Data General ECLIPSE, a Micro-nova, an ISC 8001 color CRT, two Hazeltine 1500 black and white CRT's, and a card reader.

The job is one year behind schedule due to late software. 95% of the contract amount has been paid to the contractor. Software is expected shortly and the acceptance test will proceed on its receipt.

They are also currently looking for an operator to operate the system during the prime shift. The other shifts will be monitored by guards.

There are two items of note not normally found in this type of installation. First, the software is scheduled to be delivered on tab cards instead of disks or mag tape and second, the documentation is being furnished on microfish.

SITE VISIT NOTES

MARE ISLAND NAVAL SHIPYARD

ATTENDEES:

Norman Stones	OICC TRIDENT	(912)697-2341
Pete Walmsley	OICC TRIDENT	(912)697-2341
Mark Herbach	WESTDIV	859-7381
Capt. Jacobsen	PWO/OICC MARE ISL	253-3296
Jim Dillard	PW DEPT MARE ISL	253-3375
Sam Bryson	NAVFAC HQ	221-0155
Michael Fleming	NAVFAC HQ	221-0155
Gardner Chambliss	Newcomb & Boyd	(404)352-3930
Lt. Bill Rudich	ROICC MINSY	253-4261
Nick DiMario	WESTDIV	859-7381
Frank Johnson	MINSY	253-2421
Ben Gann	Const. Rep, ROICC MINSY	253-4261
David Meginness	C/453 Util Supt. MINSY	253-4339
Vytas Nalis	WESTDIV	859-7381
Ruben MaCabitass	WESTDIV	859-7512

Contract Award Date: June 1979

Contractors:

Prime: Novato Construction Co., Inc.
Equipment Supplier: Oak-Adec

Number of Buildings: 49

Status: Estimate 75% complete

Software delayed, expected in Sept, 1981.

The software for this system has been delayed four months to a year. All hardware is in place and awaiting field checkout. The EMCS is located in the power plant and will be operated by the existing electrical control room operators. The computer and the programmer's console are located in a sparate room adjacent to the control room. This room will be environ-mentally controlled and will be locked for security.

The ROICC has done all the inspection and will only use the A&E for monitoring the acceptance test. As noted below, there have been some field problems, but the prime contractor has been very cooperative in resolving them.

Specific Field Problems Encountered:

1. Points defined in secure area: These points were later deleted. They were not cost effective after adding the additional cost of working in a secure area.

2. The "as built" drawings were poor or non-existent. Much of the equipment was very old and has been modified several times. The drawings did not reflect these modifications. Many times the controls on the equipment had been bypassed or otherwise disabled.
3. Equipment called out on an I/O schedule was not operative. There were several buildings with old unit heaters that were not functional. These were subsequently deleted from the list.
4. Phone panels shown on drawings were not of the kind that the contractor could connect to.
5. There were misunderstandings in the operation of some of the control schemes, consequently, some controls were wired wrong.
6. Field parts shrinkage: There were apparently thefts of field equipment during installation.

Specific Goals:

1. The EMCS will be used to control steam distribution. For example, it presently takes two weeks for a seasonal steam changeover. With the EMCS, much of the system can be switched by the operator. Also to save energy they would like to try duty cycling the steam on mild winter days.
2. They are anticipating a rapid rise in the cost of electricity. They want to be prepared for load shedding when the time comes.
3. They would like to use the EMCS as a maintenance tool.

SITE VISIT NOTES

JOHNSON CONTROLS, INC.
SAN DIEGO, CALIFORNIA
FEBRUARY 16, 1981

ATTENDEES:

Samuel Z. Bryson, III	NAVFACENGCOM	(202)325-0155
Gardner Chambliss	Newcomb & Boyd	(404)352-3930
Steve Bruning	Newcomb & Boyd	(404)352-3930
Norman V. Stones	OICC TRIDENT	(912)673-2341
Michael R. Fleming	NAVFACENGCOM	(202)325-0155
John R. Goodrich	JCI SSO	(714)560-8033
George Futas	JCI SSO	(714)560-8033
Robin M. Orans	WESTNAVFACENGCOM	(415)877-7381
Vytas Nalis	WESTNAVFACENGCOM	(415)877-7381

The first area of discussion was Johnson Controls' history in the EMCS area. Johnson has offered systems similar to Energy Monitoring and Control Systems since the late 1960's. Their primary product has been the JC80. That product is currently being replaced on commercial projects with a new system called the JC85. When the initial Tri-Services Guide Specification was released, Johnson Controls studied approaches to meeting that specification. Their standard commercial system, the JC80 at that time, could not meet the Tri-Service Specification. A special systems group in San Diego was set up to design and build custom systems to meet the Tri-Service Specification.

Johnsons' Tri-Service Specification system was called the JC84. The JC84 has evolved through essentially three stages of development termed by Johnson as "EMCS I, EMCS II, and EMCS III". The initial system (EMCS I) was used on the three Western Division NAVFAC projects. The specifications were released prior to official Tri-Service Guide Specifications and probably could have been met by the Johnson JC80 system. This system provided FORTRAN and utilization of intelligent multiplexers in the field. Stand alone field interface devices (FID's) were not specified. The next step in the evolution of the JC84 was termed "EMCS II". This system incorporated the revisions of the May 1978 Tri-Service specification release and included master station features and intelligent field interface device features not previously included. The next step in the evolution was development of the current JC84 termed the EMCS III. That system meets the current (March 1980) Tri-Service Specifications.

Due to the continuing evolution of the Tri-Service Specification, much system design and software effort had to be thrown out after considerable investment. This was due to

changes in requirements as the specification evolved that relate to both hardware and software architecture and distributive processing capabilities of the system.

Johnson decided to pursue Tri-Service Guide Specification systems for two reasons: 1) the Government has been an excellent client for Johnson Controls over many years; and 2) Johnson felt that spin-offs of the Government Tri-Service Spec would appear in certain commercial applications where large multi-building complexes similar to military bases were involved. Johnson felt this would be a substantial market and could justify the development of a special system.

Within the Johnson organization, the Headquarters Group in Milwaukee is responsible for design and development of standard products. The San Diego Special Systems organization was formed to address special systems which the Tri-Service Guide Specifications fall under. The original intent was to modify existing Johnson software to fit into a Tri-Service Specification configuration. In the end, the software used the basic algorithms included in the old software, but was written from scratch and not modified from existing. The primary reason was the substantial difference involved in utilizing distributed processing versus totally centralized processing.

The Johnson JC85 new generation system has in excess of 50 systems operating across the country at this time and many others under construction. The JC85 evolved from the demands of the customers of Johnson for greater programming capability, more independence from the manufacturer, and the use of more state-of-the-art hardware. These features were some of the primary reasons for development of the Tri-Service Specification.

Over half of the Johnson special systems organization business is now commercial non-military business resulting from spin-offs from the Tri-Service Guide Specification.

The Johnson JC85/40 standard commercial system will meet the proposed small and medium guide specifications for up to a 2,000 point system if distributed processing (FID's) are not required. The JC85 uses intelligent multiplexer panels, but does not perform applications functions in the field. The special systems organization's JC84 will be used for the proposed medium and large Tri-Service Guide Specifications where distributed processing is required. The largest system currently under construction utilizing the JC84 is Randolph AFB which has approximately 5,000 points. The JC85 field panels (intelligent multiplexers) are upward compatible to the JC84, however, the central hardware and software is not upward compatible. A long term goal of Johnson development is the convergence of the two product lines.

Johnson has encountered substantial delays in software development, although the field software is in the final stages and should be ready for delivery within a short time period. In addition, Johnson has encountered difficulties in the field installation side of the EMCS projects. That work represents a major cost in procuring these systems.

The configuration of the Johnson JC84 was reviewed. The JC84 is Digital Equipment Corp. central hardware based. Early generations of the JC84 utilized Data General equipment, but current versions utilize DEC equipment. All JC84 software was designed for transportability between different main frames. The software was developed with an interface to the operating system. The biggest problem encountered in transporting the software between main frames is in the operating system interface. In addition, substantial difficulties in transportability of the data base and its operation have been encountered. Data base transportability is totally unrelated to FORTRAN or higher level language considerations and is a major stumbling block in using "universal software" on different machines. In order to enhance the system's transportability, Johnson developed its own data base management system. The standard Digital Equipment Corp. RSX11M operating system is used for the JC84. No modifications are made to the DEC operating system. Johnson has used PDP11/23, 11/34, and 11/44 main frames on their JC84 systems. All software for the JC84 is written in FORTRAN. All the software is completely documented. Field interface devices are operational which meet the current (March 1980) Guide Specifications. Programs for use in the FID's are actually burned into PROM and mounted in the FID's before installation. An Intel single board computer set is used in the field interface device. Parameters for use in the programs burned into PROM are downline loaded. A DEC PDP11/23 is used as the central communications controller. The central control unit is disk based, but the central communications controller is memory based.

The JC84 is currently not listed as a UL approved fire alarm system. Obtaining UL fire alarm listing freezes the system configuration. Johnson feels that the provision of a separate stand alone fire alarm system monitored by the EMCS is a more optimum solution.

JC84 FID's are connected to off-the-shelf JC85 field multiplexer panels. The JC84 FID's do not include any function cards, all field points must first be wired through a JC85 intelligent multiplexer before tying into the FID's.

The status of Johnson Controls EMCS projects was discussed. There are three sites currently under construction for the Western Division of NAVFAC. These systems utilized the EMCS I Data General based version of the JC84. The project at Whidby

Island near Seattle, Wash. should be entering the acceptance test phase on February 17, 1981. That system has approximately 800 points. The system at Miramar Naval Air Station has been operational since the summer of 1980, however, it has a total of only 28 points and was installed for long term expansion planning. The third system is at the Naval Air Rework Facility in Alameda. The system is not yet fully operational. Substantial difficulties have been encountered with the government furnished communication system. Flooding of telephone lines is one cause of the problem. The system should be ready for acceptance testing shortly, except for some additional system integration effort which Johnson is now undertaking.

Two military EMCS projects are being provided with the EMCS II Digital Equipment Corp. based version of the JC84. One site is Randolph AFB which has approximately 5,000 points. On that project all field interface devices and field gear has been installed and is currently in the process of checkout. Field checkout for a 5,000 point system takes considerable effort and time.

The second system is being installed at Newark Air Force Station in Columbus, Ohio and is administered by Northern Division of Naval Facilities Engineering Command. The system has approximately 250 points. Considerable contractual delays have been encountered on that system. Most of the field equipment has been installed and the central equipment is being readied for shipment. The entire system should be completed by the end of the summer of 1981. The contractual delays were caused by ambiguities in the specifications regarding the disk size, the central computer, and the auxiliary power source. Submittals indicating the disk proposed to be provided were submitted in November, and were rejected, however, they were not returned to Johnson until the following June. At the same time, a modification to the contract was requested, Government furnished software would have replaced Johnson Control software, which was included in the contract. After much discussion, that approach was finally dropped. In regard to the disk conflict, the specification indicated dual 50 megabyte disk systems with dual drives which Johnson interpreted as meaning a total of 100 megabytes disk capacity. NORTHDIV of NAVFAC interpreted the requirement to call for 200 megabytes total disk capacity. This conflict is still not resolved.

Three military EMCS projects are currently under construction using the current version of the JC84 (EMCS III). Fort Polk and Fort Leavenworth each have approximately 700 points. The central equipment for each system is currently being readied for shipment and factory tests for each project is scheduled

for March. The Camp Lejeune Hospital project has approximately 2,500 points and is currently under construction.

Other non-military systems which are currently under construction include a building for Digital Equipment Corp. in Springfield, Mass.; a number of industrial facilities for International Harvester; several university campus projects; and the Center for Disease Control in Atlanta, Ga. All of those projects utilized an evaluated competitive procurement method.

Although a number of factors entered into the delays encountered in several Johnson Control projects, the most significant areas were the evolving nature of the guide specification, simply misjudging the problems involved in development of the EMCS, and the huge effort involved in writing such a major software system.

Several areas that related to procurement practices were discussed, including the following:

1. A common interpretation of the guide specifications throughout the military is lacking. There is no central authority for resolution of specification disagreements. No central resource is available for interpretation of the specification. There has been little communication between organizations using the specification to determine what has been accepted in one project versus another project. This lack of common interpretation causes extreme difficulty in bidding common EMCS where interpretations vary so widely. There is a great need for a central technical interpretation authority so that the contracts don't have to go to legal interpretation authorities. The only way to get out of the development mode and into the production mode with this type of system is to have common interpretation of the complex technical document known as the Tri-Service Specification.
2. Most of the construction administration organizations (ROICC's) don't have the technical expertise in-house to evaluate the specifications. The ROICC's have not received instructions or directives to seek technical assistance in interpretations. Since this is not customary in common building construction projects, the ROICC may not initially recognize the need for this.
3. It is imperative that EMCS be dealt with as a complex, large electronics system and not as brick and mortar with all the associated contracting procedures for building construction.

4. The procurement procedures currently being used by the military for EMCS purchasing provide no protection against unqualified bidders. The contracts are awarded based on low bid with no regard for qualifications. Qualified bidders cannot compete against other suppliers who have no experience in the area and who don't understand the problems involved in a major project. The time and money spent on preparing a bid by qualified suppliers is very significant, yet when the bids are opened and the government accepts the low bid from an unqualified, inexperienced supplier simply because it is the low bid, all that expense on the part of the qualified bidder in the preparation of bid is wasted. The end result of this approach is that qualified bidders are becoming discouraged from pursuing military work and see no reason to invest the time and effort even to bid on the projects if there is no qualification evaluation. Another factor of difficulty in obtaining honest bids from qualified suppliers is that the bidding periods are much too short (normally 30 days). Because of this, ambiguities and questions that a qualified supplier would like to have resolved in order to put in a reasonable bid simply cannot go through the government paperwork chain to obtain resolution.
5. Another area of government procurement which eliminates competition by qualified bidders is the use of small-business-set-aside procedures. Small-business-set-aside results in most of the major suppliers of energy monitoring and control systems not being allowed to bid the projects as the prime contractor. The only way they can bid the projects is through a small business organization (usually a local electrical contractor). Unless they already have a long term working relationship with a small business in the area, many reputable EMCS supplies will choose not to bid on these projects. The use of the small-business-set-aside is resulting in alienation of the industry. Extremely high investment costs are involved in the development of a system, especially to meet the Tri-Service Guide Specification issued by the government, and now the government, through the use of small-business-set-aside, is telling those suppliers who invested in system development that they can no longer bid directly on government projects. This practice leads many qualified and reputable suppliers to question whether the pursuit of government EMCS projects is a worthwhile endeavor.
6. Pre-qualification of bidders on at least a servicewide basis would be highly desirable and probably result in overall system costs that are lower. The creation of a qualified bidders list should be done using methods similar to those used for military electronics systems.

7. The use of two-step procurement procedures for EMCS is better than straight one-step invitation for bid. The advantage of two-step procedures is that the supplier can interpret the specification as part of step one. The disadvantages of the two-step procedure are that it takes a substantially longer time to bid the projects and substantial cost on the part of both the supplier and the government. Two-step can only really be justified on relatively large EMCS projects. One advantage of service-wide qualification is that two-step would not be required for each individual project and the cost of qualification would only have to be borne one time.
8. The key issue to evaluate in a procurement process is whether the procedures being used are enhancing and encouraging greater competition, or are they driving competition away and narrowing down the pool of the potential suppliers.

Plans and specifications used for EMCS procurement must be good quality coherent documents. There has been no consistency on the part of military EMCS contracts in the degree of detail of information shown in the contract documents. Where some detail has been shown, its interpretation has been detrimental to the interest of the government. For example: it is unnecessary to require a fully implemented field interface device for every building on a military base. Specifications should define performance and not configuration. One area where much more detail is required is in the field equipment design. Existing conditions must be fully documented to obtain reasonable comparable bids from all the suppliers. It would be helpful to the bidders if everywhere the guide specifications were changed for a project spec, an asterisk were noted in the margin such that suppliers who were familiar with the Tri-Service Specification could look for changes or modifications and not have them hidden within hundreds of pages of printed specs. The bidding process needs to provide greater opportunity for the suppliers to ask questions and receive clarification. The bidding schedule should not have such importance in the procurement process that later on contracting difficulties result in greater overall delays in the project. Many times the EMCS specifications try to put responsibility on the contractor without defining corresponding responsibility on the Owner's part. Examples are defining the total time period the contractor has to complete the job, and defining when certain submittals are due for review, but without specifying how long the review cycle is or how long the government will take before approving the submittals. The contract documents also need greater detail in the definition area of software licensing (Defense Acquisition Regulations 104.9A is one document that should be referenced or used).

Factory testing should allow tests to be performed on similar equipment instead of the actual equipment to be installed on the site. This would enhance the scheduling flexibility for the contractor. There is also difficulty in demonstrating "all" EMCS software during a factory test without field conditions being present. The degree and extent of the factory test should be defined in more detail. Field testing requirements should also be defined in greater detail. Validation from the console for each point and sequence called for in the system should be defined in the field testing procedures.

In the EMCS operation area, it is very important that the people who will eventually use the system be identified early and be involved through both the design and construction process. At the three WESTDIV sites the people who will actually use the systems are only now being identified near the end of construction time. Normal operation of the systems should not require any extensive technical training and should be able to be performed by a reasonably intelligent person with a high school education. To really fine tune the systems and obtain the maximum savings, however, engineering level people must be involved. A maintenance strategy for EMCS should be defined early on in the project. Currently the contracts include no mechanism for the purchase of spare parts by the user after the system is completed. If spare parts are not provided, then the maintenance training provided to Station personnel won't be of any value.

One area of concern is the definition of system reliability. There is great difficulty in defining what an average effectiveness level (AEL) really is and what it encompasses.

The use of direct digital control techniques was discussed. Johnson Controls has bid projects using direct digital control. Although their industrial division (SECD) has used DDC, the building automotive group has not to date. Johnson does not feel that the use of direct digital control presents problems as a technology, however, most of the complexity is encountered by the elaborate backup schemes included in most DDC projects. Many projects require backup by local control loops which means both the DDC control system and a local analog control system must be provided. The same problems will be encountered in the use of DDC as have been encountered on EMCS projects if the government procurement method of accepting the low bidder without any qualifications is adhered to. Within the next one to two years, direct digital control systems will be available on an off-the-shelf basis, however, that is not true at this time.

SITE VISIT NOTES

EMS/STAEFA CONTROLS
SAN DIEGO, CALIFORNIA
FEBRUARY 16, 1981

ATTENDEES:

Norman V. Stones	OICC Trident	(912)673-2341
Vytas Nalis	WESTDIVNAVFACENGCOM	(415)877-7381
Pete Walmsley	OICC Trident	(912)673-2341
Mike Fleming	NAVFACENGCOM	(202)325-0155
Samuel Z. Bryson, III	NAVFACENGCOM	(202)325-0155
Gardner Chambliss	Newcomb & Boyd	(404)352-3930
Charles A. Gulotta	SCS/EMS	(714)571-7771
William R. King	SCS/EMS	(714)571-7771
Robin M. Orans	WESTNAVFACENGCOM	(415)877-7512
Steve Bruning	Newcomb & Boyd	(404)352-3930
Wally Black	SCS/EMS	(714)571-7771
Mandy West	SCS/EMS	(714)571-7771

EMS has submitted bids on some Department of Defense EMCS projects or have participated as a subcontractor or software supplier to other prime contractors on Department of Defense projects. Projects for the Department of Defense in which they were involved include Beale AFB, Puget Sound Naval Shipyard, Pearl Harbor electrical supervisory system, and the North Island Naval Air Station. Several reasons were discussed as to why EMS has not bid recent Tri-Service Guide Specification projects. The following items were included:

1. The specification evolved with time and represented a moving target to a systems supplier hoping to provide a standard product.
2. EMS felt unlimited competition would not allow them to be competitive. Unqualified suppliers with no experience or track record are allowed to bid on Department of Defense projects. EMS could not compete with those firms and, therefore, did not expend the effort to prepare bids.
3. Government specifications in the past have not adequately addressed the limited rights requirements for software. The EMS software is proprietary and the lack of definition of the government's rights was felt to be a danger to the security of their product.
4. The Tri-Service Guide Specification was basically asking too much of the state-of-the-art. This is true particularly in light of the funds available for the projects being constructed. EMS feels that this opinion has been reinforced by the experience the Navy and other DOD

services have had on their current projects. The extended delays and problems are a result of the requirement to develop a totally new, untested system.

5. The Tri-Service Guide Spec calls for an extremely sophisticated electronic system, for which the military services are unprepared from the standpoint of educating the end user. EMS was afraid bad experience on the part of the poorly prepared end user would reflect on EMS track record. As a small company, they rely heavily on recommendations from past clients as a means of marketing and felt that the danger to their company from an uneducated, unprepared user receiving a very sophisticated system was not worth the potential profit.
6. DOD projects often were issued with very poor quality design documents. Some projects actually provided no editing of the guide specifications. The specifications were simply Xeroxed and released for bids. Even the technical notes and options brackets were left in the contract specifications. This would result in excessive conflicts during the submittal and construction process.
7. Many EMCS suppliers "bought" projects in the early Tri-Service Specification days without an understanding of the effort required to provide the software specified in the Tri-Service Guide Spec. Again, history, over the past three years, bears out this contention.

Software provided by EMS is designed to interface with a variety of field hardware protocols. In addition, EMS offers their own field interface devices on new projects. In the past they used field interface devices manufactured by Electronic Modules Corp. and are currently beginning to manufacture their own FID's. EMS feels that only 15% to 25% of the average EMCS project is included in the central hardware and software and the rest is construction in the field.

EMS would prefer to be a vendor or supplier rather than a prime contractor, although they have done both in the past. They do feel that direct contact between their technical people and the Owner is necessary and desirable to have a working system.

EMS offered several suggestions regarding Department of Defense EMCS procurement. These are as follows:

1. The systems called for by the Tri-Service Specifications are too sophisticated for the open bidding process. The Department of Defense must develop some method to pre-qualify vendors. One suggestion would be to perform qualification tests at the vendor's expense, prior to

being allowed to bid on the project. Also, past performance of the vendor should be taken into account in the qualification process. The vendors must be dedicated to the business of providing EMCS. They must also demonstrate financial stability. Other desirable qualities of the vendor is to have a broad base of experience in all the areas of EMCS involvement, including field installation, hardware, and software.

2. EMS suggests that on large projects the contracts be split in half. The field work, including sensors, wiring, interface to existing controls should be installed under one contract and the EMCS including central equipment, hardware and software, and field interface devices be installed in another contract. The process would be to select the EMCS vendor for the system and then perform a detailed hardware design around that system and bid the field installation of the system.
3. If a prequalification process were available for Department of Defense projects, then EMS would pursue being qualified to bid on projects.

There are several areas where EMS either does not meet the Tri-Service Spec and/or does not feel the requirements are necessary. Those discussed are:

1. The predictor-corrector generalized program called for in the Tri-Service Specification is not used by EMS software and they do not feel it is necessary that such a program be provided.
2. The chiller optimization package provided by EMS does not meet the Tri-Service Specification. The Tri-Service Specification requirements are overly complex and unclear in their intentions.
3. EMS only provides basic applications functions in the field interface devices, such as time schedule operation and duty cycling. They do not feel that more sophisticated optimization type functions should be included in the FID, particularly if those functions are only performed once a day, then why have them resident in the field interface device? An example of this is the start/stop optimization routines.
4. The standby requirements regarding the CCC/CCU interface are cumbersome. Experience with system reliability does not indicate the methods are required.

5. There are several other small details in which the EMS system does not meet the Tri-Service Specification.

In general, most of the Department of Defense construction personnel (ROICC) are not experienced in EMCS installation and are not capable of judging whether performance of their system is equivalent to that specified.

EMS has developed their own Guide Specification for use by engineers and owners in lieu of the Tri-Service Guide Specification.

EMS uses all Digital Equipment Corp. central hardware. The operating system used is the standard RSX11M operating system with no modifications.

EMS feels the use of direct digital control will become a dominant factor in the controls field in the coming years. They are currently marketing a microprocessor based variable air volume controller which can be daisy chained and communicate with one of their field interface devices. Their field interface devices are not currently capable of stand alone direct digital control without the presence of a central site configuration for downloading into the FID. A direct digital control system is currently operational at the University of Toronto. The system was installed as a retrofit to the existing pneumatic controls. EMS stated that outside of the United States 60% of all HVAC controls are electronic. Their experience is there is roughly a 10% to 15% premium hardware cost for the use of electronic HVAC controls, but the advantages in installation, startup, setup, maintenance and reliability makes that premium not significant.

EMS does not feel response time should be a problem due to the report by exception methods used in their systems. Where operator response time is inadequate they feel the solution is to provide additional main memory. They estimated 12 seconds was a reasonable time for the operator to advance from one colorgraphic slide to the next.

In the discussion of response time, it was noted that to use a DEC PDP11/44 with 256K words of memory instead of a DEC 11/34 with 128K words of memory (a configuration commonly offered on Tri-Service Specification products) would increase cost approximately \$22,000. This is a small investment relative to the total price of the project and yet could represent two to three times faster response time. EMS also recommended the use of fixed head disk drives for data base access on very large systems. The access time for a fixed head drive is approximately 8 milliseconds instead of the 60 milliseconds common for a moving head disk drive. The Guide Specifications should specify more main memory, the inclusion of cache memory, and faster central processing units on large projects.

In terms of system operation, EMS feels it is imperative that the system have a "system manager" who is computer oriented, but not necessarily a programmer. This person must have the capability to manage lower level operating personnel and understand the overall operation of the EMCS, both as a computer system and as an HVAC control system. It was also suggested that plans be made for each year after an EMCS is installed for retraining or providing of additional training as a part of on-going support of the EMCS. This is required due to the turnover in operating personnel and the need to provide further teaching on enhancements to the operation of the EMCS.

EMS provided a list of current projects, which is attached.

In follow up comments, Mr. King point out EMS is now called the Systems Division of Staeta Control System, Inc.

SITE VISIT NOTES

PUBLIC WORKS CENTER
SAN DIEGO, CALIFORNIA
FEBRUARY 17, 1981

ATTENDEES:

Samuel Z. Bryson, III	NAVFACHQ-0442	221-0155
Jay Keyes	PWC SAN DIEGO	958-2342
John W. Thomas	PWC SAN DIEGO	958-2342
Rich Fergin	PWC SAN DIEGO	958-2342
Gardner Chambliss	Newcomb & Boyd	(404)352-3930
Steve Bruning	Newcomb & Boyd	(404)352-3930
Mike Fleming	NAVFACENGCOM-0442	221-0155
Norman V. Stones	OICC TRIDENT 041	860-2341
Peter Walmsley	OICC TRIDENT 0413	860-2341
James L. Tisdale	ROICC San Diego	933-8835
Robert B. Wilson	ROICC San Diego	933-8645
Vytas Nalis	WESTNAVFACENGCOM	859-7381
Robin M. Orans	WESTNAVFACENGCOM	859-7512
Emil M. Orlando	NOSC San Diego	933-6204
J. Nelson Williams	NOSC San Diego	933-2019
Wm. W. Stockton	NOSC San Diego	(714)225-2019
LCDR Jim Allen	ROICC Point Mugu	(805)982-8203
Bernie King	ROICC Point Mugu	(805)982-8203
Earl Becker	CEL, Port Hueneme	(805)982-5778
Karlin Canfield	CEL, Port Hueneme	(805)982-3328

J. Keyes of PWC, San Diego opened the meeting with a brief description of the projects represented at this meeting. The primary objectives of the meeting are to discuss the following for each site represented: 1) the configuration of the EMCS; 2) the status of the project; 3) procurement/construction problems encountered on the project; and 4) what are the operational requirements for an EMCS.

John Thomas presented the experience with the North Island EMCS project. Items noted are:

1. Project specifications were pre-Tri-Service Guide Spec and were performance oriented. The requirements were extremely vague.
2. California Electric Works was awarded the prime contract with Environmental Management Systems (EMS) providing the software and Balboa Systems providing field electronics.
3. The documentation provided with the system has been very satisfactory and an operator with no formal training on the system can sit down with the manual and use the system easily.

4. The Owner has been very satisfied with their relationship with all parties involved in the project, they particularly had a good relationship with the Balboa Systems people.
5. The system has approximately 600 points, with 400 being binary and 200 analog.
6. The EMCS is primarily used for monitoring at this time and control activity has not yet been implemented. The use of the system for control is being implemented on a phase-in basis in order to accustom building occupants to the system operation.
7. Some points were included in the system that cannot be controlled for energy conservation. Examples of such points are computer rooms and other sensitive operations. If the system is primarily an energy conservation device these points provide no energy savings.
8. The Navy users feel they have been very lucky on the project to have a prime contractor and two subcontractors who are very interested in getting the job done and being cooperative. They experienced no difficulties from a change order standpoint due to the extended delays, even though some of the problems were due to government and not due to the contractor.
9. The Prime Contractor, California Electric Works, incurred substantial cost in performing the project and has decided to not do another EMCS project.

Rich Fergin presented the Navy's experience at the Naval Station PWC San Diego project as follows:

1. The system was designed around a distributed architecture configuration.
2. The prime contractor is Record Electric. The designer was Astroid and the EMCS system supplier was Radix.
3. A substantial portion of the project involved connection of boilers throughout the San Diego Area. The A/E and Navy Engineer-in-Charge never discussed this with the boiler foreman and two-thirds of the boilers connected to the EMCS cannot be shut down.
4. Another major area of EMCS application was in control of industrial air compressors. The compressors were very old and each one was unique with very intricate manual controls required to bring them on and off line. There was little design coordination with the actual field

conditions of each compressor. The plan at this time is primarily to monitor the status of the air compressor system and to determine the optimum configuration of the compressors for manual control.

5. The documentation and shop drawings called for in the Tri-Service Guide Specification is not adequately defined. The specifications should call for detailed individual FID wiring drawings, detailed field installation drawings, and detailed over-all systems documentation. The Navy feels Radix is not providing adequate documentation and is resisting the Navy's efforts to obtain it. The documentation was so inadequate that when the Navy hired an A/E firm to design an expansion to the system, the information required was not available and the contractor was not willing to provide it, so the project for expansion had to be cancelled. At North Island a system expansion was to be designed and no problems with the documentation were encountered. The documentation at North Island was entirely adequate. Sample schematics and documentation should be included with the contract specifications to define what is expected of the contractor. The contract is being closed out and awaiting licensing agreement for final documentation.
6. A number of problems were encountered due to the fact that the ROICC was not equipped or staffed to handle an EMCS type project. The Navy Project Manager must follow the project through planning, design, and construction phases. J. Keyes noted that it is their opinion that there should be a NAVFAC-wide team of experts to provide technical backup in the design, construction, and operation areas.
7. If EMCS projects are primarily for energy conservation, the point selection process must take that into account. On many projects, one-half to three-quarter of the points included are uncontrollable because of some critical condition in the building.
8. The Navy should stop paying for learning curves for each contractor on each project. One approach would be for the Navy to develop its own system with interchangeable FID's and non-proprietary software.
9. The EMCS should be integrated into the local control systems rather than imposed on top of them. ~~The entire control system, including the local controls, must operate in order to have an effective system.~~

10. Feasibility studies for EMCS should not just address EMCS, but should address all energy conservation techniques such as rework of HVAC systems for variable volume control two-speed motors, etc. Alternatives other than EMCS may have a higher return on investment, especially when the probability of effective operation is taken into account.
11. PWC San Diego will not invest further funds in Energy Monitoring and Control System projects in the San Diego area until the systems they currently have are working well and prove the energy conservation savings.
12. The EMCS studies should evaluate the use of single building programmable controllers and only connect all of those devices together when the need arises. This approach would reduce the risk involved in EMCS procurement by an order of magnitude.
13. EMCS should include graphics and plotters in addition to basic report generating to provide easier to use data.
14. The success of an EMCS project depends on the quality of the EMCS contractor than on the quality of the contract drawings and specifications.

J. Keyes of PWC San Diego discussed their approach to EMCS operation. His suggestions were as follows:

1. The systems are being operated utilizing existing people.
2. They currently have two project engineers (one for each system, one at PWC and one at North Island) who are primarily responsible for EMCS operation. These engineers work in the Energy Conservation Branch of the Utilities Division and are fully responsible for system programming, parameter entry, and operation.
3. Alarms are handled by a utilities duty desk via remote terminal. That duty desk is manned 24 hours a day and the alarms are provided with messages and instructions for the watch standers' information. This method has not actually been implemented because the EMCS systems are not yet to the point that there is sufficient confidence in the alarms to turn them over to someone who cannot evaluate them. It is imperative that a good public relations job be done with the maintenance people. They must not think that an EMCS will cost them their jobs. If anything, the EMCS will cause more work to occur due to its ability to record alarms. The Navy project at Ft Centro had an IBM energy monitoring and control system which was sabotaged by maintenance personnel due to their

believing it would eliminate their jobs. The situation deteriorated to the point that the system had to be removed and replaced with time clocks.

4. PWC San Diego is contracting for all maintenance of the systems. The North Island system currently has a contract with Balboa Systems for maintenance and a contract is now being written to request a proposal for maintenance of the PWC project.

Bob Wilson from the ROICC office for the PWC contract reported on their experiences. He listed the following:

1. ROICC could have used much more technical help earlier on in the project. In the current late stage of the project, technical help is available, but it could have been used earlier to avoid some problems.
2. The ROICC office paid progress payments on the EMCS project too soon. Out of a total project of approximately \$300,000, only around \$9,000 has not been paid, even though the system is not operational, the documentation is inadequate, and the Navy is not saving anything as a result of the installation. Current directions from WESTERNDIVNAVFAC say do not pay more than 60% of the contract until software has been accepted, according to Bob Wilson.
3. A study of the problems encountered with the systems was performed by a Reserve Officer, James T. Rodriguez in February 1980 for the ROICC office and a copy is attached to these notes.
4. The North Island system used contractor installed communications cables and encountered a number of difficulties early on in the project. Those have now been solved and were primarily due to contractor inexperience in installation of that type of cable. The Public Works Center project used all government furnished telephone lines. Significant problems have been encountered in using the telephone lines and additional difficulties have been encountered due to the lack of availability of lines which were thought to be available at the time of system design.

Nelson Williams reported on the EMCS project at Naval Ocean Systems Center. Items reviewed were as follows:

1. In November of 1980, all hardware installation was finished, but system software was not completed.

2. The system primarily serves a single building and the total project cost was \$378,000.
3. The contract was awarded in September of 1978 with Burns Integrated Systems as the prime and Compugard as the system supplier. The A/E on the project was Mitchell Webb Associates.
4. NOSC provided the technical support to the ROICC.
5. \$288,000 has been paid in progress payments and the rest is currently being withheld pending final system checkout and operation.
6. The project is currently about to start a 30 day operational acceptance test.
7. The system is not actually an energy monitoring and control system, its primary function is for monitoring and alarm of critical building functions.
8. Many of the points are comprised of a network of water leak detectors under raised floor systems on which sophisticated electronics gear is supported.
9. The system includes approximately 280 points.
10. The software has been delivered on site and appears to meet the project specifications.
11. The specifications did not provide an adequate definition of what the system actually would do. The documentation section in the specification was inadequate.
12. Compugard provided their Series I system hardware.
13. It is important to require the contractor to provide regular progress reports and to define what he is going to do before he does it, particularly in a critical environment such as is present at NOSC.
14. Some problems have been encountered with the Compugard field hardware, but it was felt this was primarily due to a lack of skill of the technicians installing hardware. Initially, many field interface device cards had problems, but those have been replaced and presently are operating adequately.
15. It is important to require the contractor to verify the power supply to the central gear. The specifications should define a range of operation (voltage) within which the system must operate. The contractor must be forced

to verify that that is the site condition. One approach might be to call for voltage regulators for both central and field interface devices. One means of defining voltage requirements would be to specify ANSI standards.

16. One problem with the system is that when a power failure and system downtime occurs, the operator must restart the system manually and manually command the downline loading process to each individual field interface device. It takes approximately 20 minutes to download all information and get restarted. The specifications did not address restart requirements and should have included automatic restart and some minimum time frame for restart.
17. The specifications must clearly require that the contractor load the data base. The specifications for this project did not clearly define this and NOSC is currently having to do that themselves. The same thing occurred with the San Diego Public Works Center systems.

Earl Becker, of the Civil Engineering Laboratory, reported on the status of EMCS at the Naval Regional Medical Center, Long Beach. The following items were noted:

1. The original purpose of the project was to perform a research and development activity.
2. Because of the research and development aspects, the Civil Engineering Lab was involved.
3. The objective of the system was to investigate the effectiveness of distributed processing. It was realized that distributed processing for the system size installed in the Hospital was an overkill, but the objective was to learn from the experience.
4. Western Division of NAVFAC supervised the design process.
5. The Civil Engineering Lab provided most of the technical input to the ROICC.
6. Substantial difficulties have been encountered regarding documentation in a similar manner as described before at PWC San Diego.
7. The project encountered substantial difficulties due to a lack of continuity on the Navy's side. Over the history of the project there have been three separate ROICC's, three separate Public Works Officers, and a number of other changes in personnel.

8. The system has a total of approximately 500 points. Asteroid was the prime contractor with Radix as the system supplier subcontractor.
9. The specification allowed either distributed processing or the use of passive multiplexer panels. This was contrary to one of the primary objectives of the research and development. The contract called for specific energy conservation applications algorithms such as optimized start/stop. Radix has failed to provide those algorithms. Radix has stated that if the government will provide them with detailed engineering algorithms, they will program that into the software. The definition of the functions in the specifications was contended by Radix not to be complete enough for them to provide the programs.
10. The factory test for the project was not attended by personnel directly involved with the Long Beach project. Radix called on a Thursday to notify the Navy that the factory test was being held on the following Monday. No one from Long Beach could make it on that short notice. The factory test, supposedly, was held as part of factory tests for several other NAVFAC jobs at which other NAVFAC representatives were in attendance.
11. Radix attempted to perform a field test without any sort of test plan. The Civil Engineering Lab would not allow this and required Radix to provide the test plan. This delayed the project by three months.
12. The initial field test was held in December of 1979, yet the system is still not ready for government acceptance.
13. The Navy is considering closing the contract out just so that they can move on with the system development. One option would be to close the contract and then hire Radix under a separate contract to help fix up the problems inherent in the system. The difficulty now is that the Navy has no direct access to Radix, who has the technical expertise, because the Navy must deal through the prime contractor.
14. The design phase of the project and review was extremely important. The Asteroid drawings were reviewed by the Navy only on a cursory basis. This proved to be inadequate.
15. The specifications should formally establish a structure of relationship of each of the parties, in other words: how the prime is related to the sub; how the ROICC is related to the Public Works Center and the A/E. Only one

point of contact should be defined on the government side. Normally, this point of contact is the ROICC, however, that is not adequate for an EMCS project because he normally does not have the technical expertise nor the man time available. The government supervision requires a full time person to follow the system from the design phase all the way through the operation phase.

Jim Allen from the ROICC office presented the status of the EMCS project at Point Mugu. The items noted were as follows:

1. The A/E on the project was R. W. Beck of Seattle. The design provided a definition of the functional requirements for the system, but did not provide a hard line detailed design. The electrical contractor who bid and won the job did not have the capability of implementing those functional requirements without a hard line design. The contractor is now requiring the government to provide that sort of detailed field engineering design.
2. The design used "as built" drawings which proved to be totally inaccurate.
3. The ROICC office is currently having the original A/E provide a detailed field design prior to proceeding with construction.
4. The project base bid was \$500,000 and after all the change orders will probably be in excess of \$1,000,000.
5. The prime contractor is Contra Costa Electric and the subcontractor supplying the EMCS equipment is AEA (Advanced Electrical Applications).
6. The EMCS equipment is being tied in to old, antiquated, existing devices which have been jury-rigged over many, many years and will probably not perform adequately for EMCS purposes.
7. The Public Works Center at Point Mugu has no idea on how it is going to staff the system, once it is operational, nor how it will use it.
8. EMCS projects are too technical for administration by the ROICC office. Some central technical resource must be provided to provide information when there is disagreement among contractors, A/E's, users, and other parties involved. There is simply not enough manpower available at the ROICC office to adequately supervise the installation of an EMCS.

9. It is hoped that the system will be finished by the end of 1981.
10. The use of a two-step procurement would probably be better than the one step invitation for bid used on the project in that a further definition of the system prior to contract award would be obtained.

The meeting adjourned for lunch and reconvened with Newcomb & Boyd, WESTDIV, OICC Trident, NAVFAC HQs., and PWC San Diego personnel only present. In addition, John Nyffenegger, of Balboa Systems, joined the group to discuss their experience with EMCS projects.

1. Balboa Systems provided the field hardware for the North Island EMCS. They have recently been awarded the contract for North Island system maintenance.
2. The Navy must address procurement methods for system expansion when the original system installation is being formed.
3. problems encountered in the North Island installation as follows:
 - a. The specification for the project was too short and left too many areas without definition.
 - b. On the other hand, the current Tri-Service Guide Specification is to the other extreme and has too much detail and too much system definition.
 - c. It is imperative that the building tenants be involved in the EMCS process from the very beginning and that they be aware of exactly what is happening and what the system is going to do.
 - d. The Navy should consider the preventive maintenance capabilities and other aspects of the EMCS in addition to the energy conservation aspects. One example is the monitoring of close temperature tolerances in critical areas. This is particularly significant in electronic environments and process type environments.
 - e. The sensor locations called for in the design drawings must be very carefully selected to be representative of the conditions desired to be measured.
 - f. North Island encountered a number of communication systems problems. The problems were primarily due to deficiency in cabling procedures on contractor

provided cable. The contractor did not have the expertise in installing that sort of cable. Balboa Systems is currently investigating the use of low speed (300 BAUD) fiber optic links. They have been dealing with 3M on the use of their cable. They feel the use of fiber optics will eliminate many of the problems inherent in other media.

4. The maintenance contract for the North Island system establishes preventive maintenance aims and requires the contractor to be on Base essentially every day.
5. It was suggested that the EMCS be eased into full operation. The system should start up just monitoring and then as tenant and maintenance personnel are more and more involved in the system, it can be eased in to control of the operation. If it is not implemented in this manner, the system could experience sabotage problems from building tenants and maintenance personnel.
6. Acceptance testing of an EMCS takes a substantial portion of time.
7. The software required by the current Tri-Service Guide Specifications is overly complicated and sophisticated, particularly where the EMCS is controlling the antiquated HVAC systems commonly found on military bases.
8. Approximately two years is a reasonable total construction time for an EMCS project comparable to the North Island system. The North Island system included approximately 150 analog points and 450 digital points.
9. In terms of response time, the North Island system uses a continuous scanning technique without any report by exception capabilities. The system has approximately a 1.0 minute scan time to update the status of every point in the system.

John Thomas conducted the group to a master control room at PWC San Diego which included both the Radix system and a remote terminal hooked into the North Island system by phone lines. John demonstrated the operation of the North Island system. No demonstration of the Radix system was given. One feature included in the North Island system was a requirement in the specifications that an 8 x 10 color photograph of every field point in the system be provided. These are in a notebook so that a maintenance man sent to the field knows what he is looking for. The photograph included labeling by point number in the same manner as is displayed on the screen for an alarm. The photographs were extremely high quality and would be very useful in introducing new maintenance personnel to the

system. After a maintenance person is familiar with the field installation, however, they provide little benefit. John Thomas noted that many problems had been encountered at the Public Works Center due to the phone line installation and the lack of cooperation from the Bell System phone company.

The group then traveled to the Naval Ocean Systems Center for a visit to see that system. Nelson Williams escorted the group and discussed the systems' capabilities. The system was actually not operational due to a disk failure. The equipment manufacturer (DEC) had been notified, but since it was late in the afternoon, he would not be on-site to repair the disc until the following morning. Because of this, the system was not operational during the visit. Nelson indicated that this was a rare occurrence and that over-all the central hardware had been extremely reliable in the year since it had been delivered. The field interface devices located throughout the building actually include a separate audible bell panel and flashing light to indicate where an alarm has occurred to the people in the area. This is used because the system is tied in to fire and smoke detectors throughout the building, in addition to the underfloor water detection system. Nelson pointed out that the purpose of the system was not really to save energy, but to monitor critical conditions throughout the building. Nelson provided a written description of the environmental monitoring system, a copy of which is attached.

SITE VISIT NOTES

COUNTY OF SAN DIEGO
SAN DIEGO, CALIFORNIA
FEBRUARY 18, 1981

ATTENDEES:

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Robin M. Orans	WESTNAVFACENGCOM	859-7512
Ray Miller	County of San Diego	(714)565-5458
George Parker	County of San Diego	(714)565-5458

The County of San Diego provides tours to many people interested in EMCS and all they ask in return is a letter of thanks for publicity purposes.

The system at the County of San Diego was a pioneering system in the distributed processing area. In 1973 the County hired Engineering Supervision Company as their architect/engineer to do an energy monitoring and control system study. The specifications for the system were written by Ray Dixon who is no longer with Engineering Supervision Company. One of the primary fears on the part of the County was that they did not want to get locked in to a proprietary system. Technical proposals were used with a point scoring system to evaluate the bids and eliminate unqualified bidders.

It is important to recognize that even if the EMCS is built into new buildings, the installation is still in effect a retrofit on top of the local control loops. They have had problems with getting some of the consulting mechanical engineers designing their new buildings to learn the potential of the EMCS and to integrate it into the new building control design. One problem area is that the knowledge of wiring for an EMCS type system is still vested in the Honeywell and Johnson Controls type contractors so that if an electrical contractor is expected to do the field installation for an EMCS, the detailed design of the field wiring must be provided for that electrical contractor.

The County of San Diego system uses a Digital Equipment Corp. PDP11/45 central computer which is connected to 4 separate complexes. Each complex has its own satellite processor. The first complex is the County Operations Center which has 17

data panels with a total of approximately 1,000 points. The second site is the Vista Regional Center approximately 50 miles from the County Operations Center, with 16 data panels and approximately 800 points. The third complex is the County Administration Center located 13 miles from the central location using 16 data panels handling approximately 700 points. The fourth complex is the Juvenile Probation and Courthouse, which is 4 miles from the County Operations Center, and includes 5 data panels handling approximately 300 points.

Two other regional centers are currently under construction and the EMCS is being expanded to include those centers.

In the design process it was felt that there must be an "operator address" scheme for addressing points. This scheme defined a point by first defining the complex, the building, the system, and then the point at which the points are located. Also, the same point number is always used for a specific type of point. In other words, point #2 throughout the system is always an Equipment Control Point. This approach was felt to be absolutely necessary for operator ease on a large system with several thousand points. They felt it was imperative to stay away from a hardware address scheme such as, in FID/CARD/POINT. Their system actually allows the use of either addressing scheme, but they felt it was imperative that the operator addressing scheme be provided, particularly for persons who use the system on an intermittent basis.

Howard Electric Co. was the original prime contractor on the EMCS construction, with Compugard as the EMCS system supplier subcontractor.

For the system expansion projects they are taking the approach that the expansion must use identical Interface Panels (FIDS) and Satellite Processors (PPU). The actual field wiring and installation will be bid as a part of the building construction, but the County will furnish the FIDS, Satellite and related software (purchased on a sole source basis) to the successful bidder for installation. They feel that on an expansion only 30% of the cost is field interface device and 70% of the cost is field work. Therefore, using this approach, they are able to bid 70% of the work on a competitive basis and only a relatively small fraction is purchased on a sole source basis.

The average building operator cannot properly relate to CRT's and complex control strategies. The traditional building operator training is oriented toward simply pushing a button and letting the systems run. There is a need to have central automation control so that engineers instead of operators can really make the systems run as they are designed.

The central computer includes foreground/background capability. Preventive maintenance programs are currently being developed in-house in the background mode. Difficulties were encountered with the County electronic data processing (EDP) department, who felt that the computer for the EMCS should be taken out of the facility people's hands and handled by the computer department. This is a bad approach, since the computer is really just a part of a process control system and not used for data processing as such. Also, most of the electronic data processing personnel do programming in COBOL and are not familiar with the languages used for EMCS operations. Two years ago some preventive maintenance programs were given to the EDP Department for writing and two years have since passed with no results. This is primarily due to lack of experience in the language and the needs or requirements for the programs.

The operation of the EMCS is performed using a team approach. The team consists of a mechanical engineer, a computer programmer, and a maintenance technician. There are no actual "operators" of the system. George Parker is the Manager of that team as part of his duties as the Chief of Facilities Services. This group is primarily responsible for energy conservation and is not a part of the Building Maintenance Staff.

Satellite processors at each complex consist of a pair of DEC LS11 computers. These processors were placed at each complex due to an original design requirement that the local operating engineer at each complex determine the local control. One of the satellite processors is strictly a communications processor and the other one is a control interface processor connected to a CRT and printer used by the local operating engineer. From a satellite processor the local engineer can display, monitor, and control all points within his complex. He can also do trend logging and implementation of varying time schedules. Dedicated commercial leased lines operating at 1,200 BAUD back to a central at the County Operations Center are the communication links.

George Parker reports directly to the Director of General Services. His primary responsibility is energy conservation activities.

At this time, no demand limiting activities are implemented on the system, although the system does include demand reporting and metering capabilities.

The applications programs supplied by Compugard worked as long as Compugard personnel were on-site to nurse along the system. When the software warranty expired the County used an in house Programmer to maintain, debug, and in some cases rewrite

applications software. The County has had excellent results with the Compugard hardware, operating and communications software, however, they have experienced failures using the Compugard applications software.

The County feels most of their success in using the EMCS is the result of manpower and efficiency improvements, but, as yet, energy conservation improvements have been minimized due to the energy conservation programs implemented prior to the installation of the system.

Central computer background mode programs have been developed to take utility billing data and produce management reports giving BTU per square foot, dollars per square foot, utility rates in dollars per kilowatt hour, dollars per therm, total kilowatt hours, total therms, etc. The reports also provide a summary for all facilities. These reports are used as a management tool and are circulated to all department heads to demonstrate each department's activities in the energy conservation area.

The system originally included detailed electrical metering of individual pieces of equipment. Since beginning operation, the system is now being modified for total building metering and not individual metering. Many problems were caused by FID downtime and the loss of pulse counts, and thus the receipt of inaccurate information.

It is important that the user be self-sufficient from the standpoint of the EMCS to be successful. The user cannot rely totally on the supplier (Compugard). The users must have sufficient training to stand alone in all areas, including operation, programming, maintenance, etc.

The system at one time included as a test case a colorgraphic CRT which has since been removed. The operating personnel found it is too much trouble to deal with, maintain, and operate.

The satellite processors do not really perform intelligent functions. They handle communications processing, units conversion (HEX to engineering units), local interface to operators, and some time control functions. All sophisticated applications functions are actually performed at the central computer.

Turbine flow meters were used in a number of cases and they have never successfully operated.

The total system has over 3,000 points, however, some of these points are now felt to be extraneous and they really have far too many points for what they need.

SITE VISIT NOTES

CAMP PENDLETON MARINE CORPS BASE
CAMP PENDLETON, CALIFORNIA
FEBRUARY 18, 1981

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Robin M. Orans	WESTNAVFACENGCOM	859-7512
Bob Nichols	MCB Camp Pendleton	(714)725-3101
Ron Bryan	ROICC, MCB, CP	(714)725-3136
A. E. Probst	NRMC Camp Pendleton	(714)725-3611
L. W. Hammett	Fac. Maint. C. Pen.	(714)725-4820
S. A. Corrao	Public Works C Pen.	(714)725-6261
D. C. Edwards	Chief Eng. PWO	(714)725-5915
Robert Ziss	MCB Camp Pendleton	(714)725-3384

Robin Orans from Western Division NAVFAC explained the purpose of the visit and introduced all personnel present. The following items were included in the discussion:

1. The original EMCS at Camp Pendleton was a Honeywell Delta 2000 System installed around 1972. Its primary objective was manpower savings through boiler monitoring. A large number of boiler patrol tours were required because of the large geographic area covered by Camp Pendleton. By using the Delta 2000 for boiler monitoring, these roving patrols could be reduced. The two-step procurement process was used for the original system with three bidders responding. The original equipment is still in operation and Camp Pendleton has never had to throw away any piece of the EMCS as it has been expanded over the years. The General Accounting Office performed an audit of energy savings claimed by Camp Pendleton and the audit report stated that, if anything, the savings were probably underestimated.
2. There have been four additions to the original system over the years and Camp Pendleton has been very satisfied with the system performance.
3. It is very important to have a single manufacturer of the entire system so that that manufacturer has total responsibility. Camp Pendleton has continuously had a maintenance service contract on the entire system since

the first piece of equipment was installed. The original system and all subsequent additions have been provided by Honeywell and most Camp Pendleton personnel have been very happy with Honeywell's support capabilities.

4. The original system and additions have used a wide variety of procurement methods including two-step, sole source, and small business set aside. On the latest expansion the Tri-Service Guide Specification was used, however, with requirements that all existing equipment had to be reused and small business set aside, this resulted in only one bidder on the project, Southern Contracting Company with Honeywell as subcontractor.
5. The fact that Camp Pendleton has had continuous maintenance on the system has been a very significant advantage compared to EMCS operations at other sites. If maintenance had not been continuous, then system responsibility would have been divided and resulted in difficulties.
6. It is very important that the EMCS design include great detail on the existing field conditions. Even though this takes substantially more time and expense in the design phase, the savings in the long run are well worth the additional effort.
7. After the current expansion contract is finished, there will be a total of 411 buildings connected into the EMCS.
8. The current expansion project is adding 142 buildings to the system.
9. The existing system consists of 5 Delta 1000 units in 5 different areas of the Base. The expansion will connect an additional Delta 1000 and all of those Delta 1000's into a common system feeding in to a Delta 5100 central.
10. One difficulty encountered on the last addition was that the project was funded by Energy Conservation Investment Program (ECIP) funding and the A/E designer had to meet that criteria in his point selection. The result of this was that many of the functions desired by the Base operating personnel for maintenance purposes could not be included in the system.
11. One of the primary limitations of the system currently at Camp Pendleton is imposed by the telephone system not having enough spare capacity. All long distance communications done by the EMCS is over government furnished telephone lines. The limits on telephone system were caused by a Honeywell original statement that no addi-

tional pairs were required. Subsequent to this the Honeywell requirements doubled in some cases with no advance warning.

12. The maintenance contract has been advertised each year on a competitive basis, but Honeywell has gotten the contract each year.
13. It is important that the maintenance response time included in the specifications be at a level that requires the system supplier to have a local maintenance man within hours of the site.
14. The central console for the EMCS is manned 24 hours per day.
15. On-going training should be provided in addition to the single large training sessions included in the Tri-Service Specification. One approach would be to do early training on the system at another site that is operational while the project is under construction at the user's site.
16. EMCS operators at Camp Pendleton must be qualified as boiler operators. This qualification results in the ability to provide higher pay grades and ask for more experienced personnel.
17. There are no operators at the Delta 1000 sites.
18. Papers have been written documenting the savings resulting from the Camp Pendleton system for presentation at the SECNAV Energy Conservation Course.
19. The Navy Hospital on Camp Pendleton was discussed. The Hospital has a Powers Regulator automation system (EMCS) for monitoring of conditions and manual control. The system was installed as part of the hospital construction in 1974. The system has been satisfactory, but is currently out of date and difficulty is being encountered in obtaining spare parts for the system. The system is used as the heart of the Hospital's energy conservation program and energy costs at the Hospital would rise substantially if the operation of the EMCS was lost. The system includes approximately 250 points. The system is now in the programming stages for replacement. Initially, a maintenance contract was included for the system, but was later dropped because of the lack of experienced personnel from the local Powers office.
20. The ROICC strongly suggests the use of Title II A.E. services to assist in inspection of the projects. The

ROICC office, in general, does not have the manpower or technical expertise to handle an EMCS project.

21. One approach to procurement of the EMCS would be to require that the contractor install the central equipment and connect up one building which could be used to prove that all software and all system functions are operational, and then allow that contractor to proceed with construction in additional buildings. This would prevent having most of the construction project completed before any of the system is operational and would prove that the contractor is capable of performing his job as part of the system procurement.
22. In new buildings under construction at Long Beach, the EMCS including field panel sensors, etc., have been included in the construction contract. This has not locked the building controls into Honeywell as a supplier. In some projects Honeywell has supplied the building controls in addition to the EMCS devices and in other projects other controls companies have provided the building controls with Honeywell only providing the EMCS equipment. They have not flat specified that the field panels would be Honeywell data gathering panels, however, the specs have called for the requirement that data gathering panels provided be compatible with the existing Honeywell EMCS.
23. Consideration should be given to installing FID's in locations other than mechanical rooms. Difficulties have arisen as a result of direct water contact in the electronics of the FID. This has occurred due to leaking pipes, hoses down to clean the mechanical room, and other conditions. One approach would be to locate the FID within a building proper.
24. It is important in the construction of the master control room to properly seal all openings to keep dust from the computer equipment. Also, no smoking can be permitted within the computer room due to degradation of the electronics.
25. Prior to the current expansion project, the total investment was approximately \$2,000,000 in the EMCS and the maintenance contract was running approximately \$120,000 per year from Honeywell. The current expansion project will raise the total construction investment in the system to approximately 3.7 million dollars.
26. The system has experienced minimal downtime over the years. Complete system downtime is on the order of a few hours per year. Battery backup is provided for each of

the Delta 1000's and the central equipment, but not on any of the field data gathering panels. Numerous "down-time" that required troubleshooting of telephone lines by Camp Pendleton telephone personnel have occurred however. These problems were often found not to be cable troubles but instead were EMCS equipment problems. The determination of responsibility for a problem is one difficulty in using government furnished telephone lines for EMCS Communications.

27. Honeywell has stationed or assigned a maintenance man on-site full time, in addition to sending other personnel out from their office on a periodic basis so that they can stay familiar with the EMCS at Camp Pendleton. The Camp Pendleton operators confirm that problems with the system are actually Honeywell problems before calling Honeywell for service. If Honeywell is called and the problem is actually due to malfunction in Base equipment rather than Honeywell equipment, the Base is charged for that service call.
28. The EMCS is currently managed under the Utilities Department of the Base Operations. A study is now underway as to where within the management chain the system should lie and whether it should stay within the Utilities Department. The system operator is actually the Foreman in charge of the roving boiler patrols. The operators work very closely with the Engineering Division in the use of the EMCS.
29. The Delta 5100 will include a colorgraphic CRT, although it was not delivered to the site as yet.
30. Camp Pendleton provided a descriptive brochure of their EMCS, copy of which is attached.

SITE VISIT NOTES

ADVANCED ELECTRICAL APPLICATIONS
RIVERSIDE, CALIFORNIA
FEBRUARY 19, 1981

ATTENDEES:

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Vytas Nalis	WESTNAVFACENGCOM	859-7381
Robin M. Orans	WESTNAVFACENGCOM	859-7512
Steve Schillinger	Adv.Elec. Appl.	(714)781-6910
Martin Smaha	Adv. Elec. Appl.	(714)781-6910

Robin Orans of Western Division, NAVFAC introduced all attendees and explained the purpose of the visit. The following items were discussed:

1. Advanced Electrical Applications (AEA) provides systems engineering and integration only. They perform no manufacturing and all equipment is purchased and integrated and software is written for it. AEA does have the capability of black box design for interfacing, but is not generally in the manufacturing field.
2. AEA is currently providing SCADA systems for the U.S. Department of the Interior, Water and Power Resources Service for use in control of high voltage distribution and pump control for large irrigation projects.
3. AEA has worked in conjunction with Radix, Compugard, Johnson Controls, and Oak-Adec.
4. EMCS projects for the Department of Defense are currently running substantially behind schedule because all the software required for meeting the Tri-Service Guide Specification had to be developed from scratch. Software was not available when the specification was first used.
5. Substantial difficulties have been encountered as a result of turn-around time on submittals. Submittals have taken extremely long times from when they are submitted to the government to when comments are returned to the contractor. The construction times specified in the contracts could not be met due to the time taken for transmittal and review of all the submittals by the government.

6. In addition to the above, the construction times specified on most DOD EMCS projects are not long enough. After the EMCS systems are fully developed, it still will probably take approximately two years from the time of contract award to construction completion. The time for data base entry on large systems can take months.
7. AEA is a systems supplier for the Point Mugu Navy EMCS project. Point Mugu includes approximately 500 points in 15 buildings. The problems encountered have been due to a lack of clarity in the plans and specifications. Vagueness was encountered throughout all the contract documents. The input/output summaries did not show all points expected to be included in the system. Some points were called for in two or three lines of hidden paragraphs within this specification, but were not included in the I/O summaries. One example was a paragraph which called for feedback on all control relays, however, none of those feedback status points were shown in the I/O summary. These were not discovered during the bidding period and resulted in conflict between the contractor and the government.
8. Most EMCS projects have much too short a bidding period. By the time the plans and specifications are received by the bidders, there may be only two weeks available for bidding the project. That is not enough time to do a quality job of bidding on large projects.
9. The specifications used on DOD projects have too much detail. They require special custom devices instead of specifying functional requirements. An example of this requirement is the requirement for a separate function key pad. If a special device must be specified, then its manufacturer's name and model number should simply be called out rather than calling out details which are difficult to define or to track down. Too much detail such as requiring a certain number of registers or a certain number of vectored interrupts, etc., does not add to the system definition, yet can result in many headaches in the construction process in trying to prove that the system meets the requirements of the plans and specs.
10. The EMCS should try to use commonly available hardware without any specialization. Don't specify features that only custom built devices have available. Try to use off-the-shelf hardware.
11. It is important to require commonality of equipment in the master control room in order to obtain a maintenance contract from the computer supplier. AEA uses this

approach, even though it is very expensive for them, however, they feel it provides the best performance both to them and to the customer.

12. AEA is not in the business to maintain systems. Maintenance contracts are obtained from standard hardware suppliers such as Hewlett-Packard. The EMCS owner must decide which manufacturer is responsible for a problem or whether the problem is occurring in software and maintain the system himself. Where that is not practical, AEA has subcontracted to local computer dealers to provide local maintenance services.
13. In the field interface devices the S100 bus is used because of its wide availability from different manufacturers. The Cromemco single board computer is used in most of AEA's applications of field gear and central communications controllers.
14. In order to maintain EMCS, the user personnel must be qualified electronics technicians. The problem encountered in using military people is due to the short rotation period of the military assignments. AEA provides cassette tapes as an auto-training aid for new people using the systems.
15. Unnecessary details should be deleted in the Tri-Service Guide Specifications systems software area which might require an EMCS supplier to modify the computer manufacturer's operating system.
16. There is a disparity in the Tri-Service Guide Specifications between hardware and software specs. The hardware spec is very detailed to the point of calling for hardware multiply and divide. The spec really should say that the manufacturer's standard operating system should be provided without attempting to specify detailed contents of that operating system.
17. In the Tri-Service Specification for software, conflicts exist between applications programs versus command programs, for example: the cycling control sequences called for in the command software section conflict with the duty cycling applications programs. Another area of difficulty on DOD projects is encountered where programs are specified that don't even have an application on a particular site, such as chiller optimization. Also, other areas of the software specification are insufficiently defined such as the algorithmic control sequences.

18. Another area of conflict encountered is that of the program outputs from a software standpoint versus the type of points actually called for in the field. An example is where an analog output value from a software program attempts to control a binary type point controlling unloading of a compressor.
19. The field installation design should be completely detailed.
20. AEA feels that if the field installation was provided with a detailed design it would cut the final cost of the construction contract between 7% and 20%.
21. The side benefits obtained from maintenance usage of the EMCS are very substantial. The Department of Defense projects are not fully addressed in this area in terms of points provided or software for base maintenance usage.
22. AEA's experience with the use of current transformers on equipment power supplies as a status indication on equipment is that this approach is very valuable for diagnosis of problems in equipment operation. This is much more expensive than the simple binary air flow switch or water flow switch feedback, however, it is extremely useful on larger loads (5 HP and above).
23. One area of weakness in the Tri-Service Specifications is a lack of clear definition of what constitutes an alarm within the system.
24. In regard to system expansion, it is important in the first phase of the EMCS construction to specify the eventual system that will be expected to be a part of this central site. Items that should be specified are the eventual number of buildings, number of points, number of FIDS that will be tied into the system eventually. The use of percentages to attempt to define this is very vague and should be avoided.
25. Due to the Department of Defense procurement process of accepting low bid with no qualifications, AEA, as other contractors, has to look for vagueries in the specifications in order to provide a low bid and be competitive.
26. Even if the specification for field design is overly specific, that is still better because all people bidding the job will have to bid the same thing. For example: it is better to flatly specify a 150 megabyte disc drive which would be more than enough memory, than to vaguely say the disc must be sized to handle all software and X

number of points and "X" percentage of expansion. The result of that type of spec can be one contractor bidding with a 5 megabyte disc drive while another contractor bids with a 20 megabyte disc drive. This results in cutthroat competition and encourages "barely get by" approach on the part of the contractor.

27. If the user is anticipating the use of a particular function in the EMCS such as chiller optimization, then at least one chiller should be included in the original phase of procurement so that the software for that chiller or for chiller optimization can be tested and demonstrated, even though the bulk of those systems won't be connected until later.
28. EMCS response time was discussed. There are three types of EMCS data acquisition: one is a point by point scanning technique; two is poled (report by exception) technique; and three is a field initiated interrupt technique. These are all forms of gathering data for the EMCS. AEA uses the poled reporting techniques. Response time is heavily dependent on which of the three techniques is used and what the protocol is on the system, the protocol being defined as what data is transmitted back and forth in what format. Protocols can be broken in to two classes which are: (1) BIT oriented; and (2), BYTE oriented protocols. AEA uses BYTE oriented protocols because of the availability of off-the-shelf devices for handling of that protocol. BIT oriented protocol is actually faster. The typical AEA message consists of a start of transmission BYTE, a BYTE count BYTE and address BYTE, a command BYTE, data BYTES, a CRC BYTE, and an end of transmission BYTE. Thus, seven BYTES are used for transmission from the central to the FID and upholding process, seven BYTES are sent from the field to the central if no change has occurred. If a change has occurred with a binary point then an additional two BYTES are sent in the message from the field. If an analog change of state has occurred, an additional three BYTES of data is sent. Therefore, the response from the field interface device to a polling for the AEA protocol results in seven BYTES plus two times the number of digital change of states plus three times the number of analog change of states. Using these equations, the quantity of information can be calculated for any given set of field conditions. Knowing the total number of BYTES to be transmitted and the BAUD rate, then a maximum or a minimum response time can be calculated. One difficulty in attempting to specify system response time is that unless the field conditions are defined, under which that response time is measured, then the system response cannot be calculated or estimated. On the New Mexico Interior

Department projects response time measurements were defined appropriately and a copy is attached.

29. Response time is also relative to the device connected to the EMCS. For example: the response time on a badge reader must be totally different than a response time on most HVAC points connected to the EMCS. The badge reader for personnel access to an area must immediately be responded to, whereas most EMCS points really don't need nearly that type of response.
30. On the Travis AFB project where AEA teamed with Radix as a supplier. Much of the software had to be rewritten by AEA.
31. In a procurement process, base suppliers should be required to show existing systems that are similar in terms of technical difficulty to determine whether or not the company has technical competence and would be allowed to bid the project. AEA is not particularly in favor of a two-step procurement process on each project because of the substantial time and expense involved in the two-step process. It would be preferable to have an over-all Department of Defense or servicewide approval of the contractors rather than go to the expense on each project.

SITE VISIT NOTES

OAK-ADEC
LOS ANGELES, CALIFORNIA
FEBRUARY 19, 1981

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Vytas Nalis	WESTNAVFACENGCOM	859-7381
Robin M. Orans	WESTNAVFACENGCOM	859-7512
Dom Genovese	Oak-Adec	(714)540-8863
Jerry Smith	Oak-Adec	(714)540-8863
John Atkinson	Oak-Adec	(301)561-1050
Dick Wells	Oak-Adec	(714)540-8863

Oak-Adec's system configuration was discussed as follows:

1. Oak-Adec manufactures field interface devices (FID's) and multiplexer units (MUX). They also are in the systems business, primarily because that is the best way to sell their manufactured products. Oak-Adec provides software and system management for EMCS projects.
2. Oak-Adec purchases computers sensors and field installation from outside suppliers.
3. Digital Equipment Corp., DEC hardware is used exclusively by Oak-Adec. The primary reason is for superiority in service. The central communications controller is a DEC PDP11/03, the central control unit is a PDP11/34 on most projects, with an Intelligent Systems Corp. colorgraphic CRT used as the operator's terminal.
4. Up until three years ago all software development by Adec was contracted out. At that time they decided to develop in-house capability and now have eight to nine full time people in the software development area. Outside services are still used for obtaining software personnel for peak load leveling.
5. Adec's MUX panels meet the IMUX specification in the Tri-Service Guide Specifications. The MUX is Z80 based and is manufactured on a single card including all field functions. This card handles up to 16 digital inputs, 16 digital outputs, 4 analog outputs, and either 16 high level analog inputs or 8 low level analog inputs (RTD's).

6. Oak-Adec's field interface device, FID's, do not connect directly to any sensors. The FID's must talk through the MUX panels. The FID is Z80 based with one card provided for memory and one card as the central processing unit.
7. The programs for use in the field interface device are burned in to PROM and only parameters are downline loaded from the central.
8. If a MUX is added to a field interface device, then the PROM would have to be reburned.
9. Both the FID and the MUX panels report by exception for field data update.

The status of Oak-Adec projects was discussed as follows:

1. When the original Tri-Service Guide Spec was released, no one had hardware or software available to meet it. Unfortunately, this spec has been a constantly moving target and thus has provided a primary reason why system suppliers have been late on projects. The system suppliers have attempted to design their hardware and software to meet the specification requirements and as they get a certain distance along on the development of that requirement a new version of the spec is released and much of that development goes down the drain.
2. The hardware design of Oak-Adec systems is finished and hardware production is underway. 90% of the field interface devices and MUX's for the Trident-Bangor project are already on site. Adec actually has much more production capability for hardware than they have orders at this time.
3. As yet, Oak-Adec does not have a Tri-Service Guide Specification project that has been completed. They feel they are very close on seven or eight projects. Department of Defense projects in which they are involved are Mare Island, Subbase Bangor, the Patuxent River Naval Air Station, Peterson AFB, field hardware on the Point Mugu Naval project, Fort Knox, Ky., Tyndall AFB, Fort Jackson, Robins AFB, University of Texas at Houston, the Texas Department of Corrections, and the University of North Carolina.
4. Oak-Adec software to meet the Tri-Service Specification is not yet completed. Teams are visiting each site around the country to check out the hardware installation and to prepare for software. Within the next two months some parts of the software will be delivered to the sites and installed. Within three to four months at least one

site will be completely installed and begin acceptance testing. These time frames are an estimate only and there is no way to be sure that the software will be ready in those time frames. All of the elements of the software have been developed on various projects over time and most of those elements are working in field installation. However, the task at hand now is the integration of all of these pieces of software into a comprehensive working system.

5. Oak-Adec feels it is important to consider a phased installation and acceptance of software.
6. Documentation is proceeding as the hardware and software is developed. All hardware documentation has been completed and much of the software documentation is completed.

The requirements of the design process were next discussed:

1. In terms of the Guide Specification, it is felt that it is good from the standpoint that the Department of Defense doesn't have totally different specifications on every job, however, it is bad from the standpoint that some engineers simply Xerox the spec (including the technical notes) without any regard to the project at hand. This problem stems from the fact that some engineers either can't interpret the Tri-Service Specification or conversely, if he does interpret it, his interpretation may be totally different than what has been experienced at other sites. There should be some higher level of authority for consistent interpretation of the Tri-Service Specification. Some older Guide Spec versions actually had errors that have now been corrected, yet on some projects those requirements are being enforced by Contracting Officers or engineers who are not familiar with later developments in the Specification. This has resulted in numerous contractual contests and debates.
2. Drawings on Department of Defense projects vary from excellent to poor to non-existent. Difficulties have been encountered where the input/output summaries don't include all points in the system, yet some paragraphs within the specifications infer that additional points are required. The input/output summaries must show every single point in the EMCS. The area in which improvement is most needed is in input/output summaries. Closer coordination is needed between the points provided in the field and the functions to be performed by the EMCS. The detailed drawings should be provided of all field work indicating what is required for each point. Also, not

enough information is provided in terms of what points need to go into reports specified by the specification, which software program, etc.

3. The total cost of EMCS installation would be substantially reduced if detailed work was done during the design process and not left up to a guessing game on the part of the contractor. There is no way to exactly quantify how much would be saved, but there is no doubt that it would be less expensive to perform that effort as a part of the design than later as a part of contractor change orders.
4. There is a distinct need for early user involvement in the design process and coordination of the points and function selection.
5. The detailed field design should show existing conditions, but still should allow variation for the particular contractor's configuration so that the contractor can take advantage of the economies of his particular systems.
6. At the Subbase Bangor points were actually located as part of the design process by placing stickers in the field where the points were actually to be installed. This approach has proven extremely useful in the site installation process on that project.
7. The design should more carefully address where MUX and FID locations are to be provided and should consider the environments in which those locations are shown.
8. The design should indicate exactly what is to be shown on each nameplate of each device in the system, if nameplates are to be provided. For example: what labelling should be included on each temperature system sensor?
9. One area of the Guide Specification that cannot be met on most military installations is the requirement for a laminated plastic control diagram to be mounted in each Mechanical Room. This Specification does not sufficiently define what is to be included on that diagram and if the intent is to show the local controls, then existing local control diagrams must be provided to the contractor. These, in general, are not available.

Alternatives in the procurement process were discussed as follows:

1. Competent contractors simply cannot compete against ignorance. A danger inherent in this one-step invitation

for bid is the possibility of a mistake or total misunderstanding on the Contractor's part and ending up with an extremely low bid from an unqualified supplier.

2. One approach to improving the performance of Navy EMCS projects would be through the use of prequalification of contractors. One way to do this would be to look at the history of the proposed contractor in industry and to prequalify the bidders even before the specifications for the project have been prepared. Once that prequalification is done, then the drawings and specifications can be geared to those contractors who have been prequalified.
3. The most objective way to do procurement for an EMCS that has been used so far is probably the two-step method where technical proposals are submitted for evaluation and then contractors are allowed to bid.
4. A danger in attempting to prequalify contractors is that whatever method used must be objective. If a subjective method (i.e. point system) is used that would not award the project to the low bidder, then many legal problems would be encountered.
5. If prequalification is to be done, then it should be done prior to accepting bids. One difficulty is there is no way to objectively evaluate technical comparisons for the derivation of a point system.
6. EMCS construction projects should more carefully evaluate the construction time requirements included. If all of the submissions included in the Guide Specifications were followed exactly, eight months would elapse before any field work could be done. Oak-Adec feels that from one to two years would be a reasonable construction time for projects after the systems are completely developed. The designers must keep in mind that anything that is unique, for example a high security area, must be specified and additional time allowed for that unique requirement. One way to speed up the construction process would be to have existing conditions retrofitted or repaired under a separate contract and have that already underway before the EMCS starts. Some EMCS work could actually be done under the separate contract. Some items are common to each EMCS manufacturer such as contact inputs or relay outputs, however, much care must be used in splitting up the effort, for example: analog input sensors are unique to each manufacturer and to provide total responsibility they should be specified or provided by the EMCS manufacturer.

7. The addition of FID's or MUX's by other than original suppliers in an EMCS expansion project is simply not practical. It is not the type of system expansion is not being done with big main frame computers and there is no reason to believe that such an approach could ever be done in the EMCS field.

Difficulties encountered in the construction process were discussed:

1. Site conditions are not adequately shown in the design documents. The systems in the field should work before the EMCS is applied to them.
2. When government furnished phone lines are used, they must be reserved at the time of design. Difficulties have been encountered where lines were available at the time of design but when the construction process was ready to use them, the phone lines had been used for other purposes. Also, more detailed definition of the telephone line characteristics must be included. Simply specifying three 002 lines is not enough definition.

Adec's experience in the EMCS operation area was discussed.

1. Most sites have not been adequately prepared to receive the system. At many DOD sites the end system user does not even have a man available to attend the training at the time the training is ready to be provided.
2. The operation and continuous training scheme planned for Subbase Bangor is one approach to providing a phased in change over. That scheme utilizes contractor personnel to operate the system in a phased down approach of the first year with user personnel phasing in and working along side of the contractor personnel. The cost of that operation and continuous training as specified was \$440,000 out of a 3.9 million dollar construction project.
3. It is important to have user personnel on board early so that they can be used to track down data base information.
4. In general, the higher the level of training of the EMCS user personnel, the more benefit will be received from the system.
5. The system must have dedicated people full time with expertise in the systems they are controlling in order to have a useful, beneficial EMCS.

6. Even though technical qualification is important, even beyond that a primary need is to have interest on the part of the people who are using the system. Technical qualification can be overcome with proper training, but lack of interest cannot.
7. One approach that should be considered is having a centralized training group within the Navy so that users could send people to school in the future beyond the construction phase and that course could also include expanded energy management training, in addition to simple EMCS operation training.

Different approaches to EMCS expansion were discussed as follows:

1. Oak-Adec feels that the Owner must recognize that he essentially will never be independent of the first systems supplier on an EMCS project. Even though with the documentation specified in the Guide Specs, expansion or modification of the system by other than the original system supplier could be done, it must be understood that this is simply not economically practical or probable. The cost for someone other than the original system supplier to understand and be able to modify the system is simply prohibitive.
2. Another area of caution as regards system expansion is the fact that systems cannot be added to during the warranty period. If systems are modified during the warranty period, in general, that modification voids the warranty requirements.
3. A unique and apparently successful approach to system expansion was used at the University of North Carolina on a Tri-Service Specification type system. Their approach was to select a low bidder based on a total system life installation cost and not on the low bid for the first increment of the construction. Unit prices provided by the suppliers were used to calculate the ultimate system price. This phase was not entered into until after prequalification of the bidders through the use of technical proposal. Unit prices quoted did not include installation cost simply because it could not be well enough defined (wire, conduit, etc.). The plan is that future expansions will be competitively bid from the standpoint of field installation, however, the system equipment will be supplied on a negotiated basis using the unit prices quoted in the original system document with an allowance for cost of living inflation. The people to contact at the University of North Carolina to obtain information are Gene Swecker at (919)966-5471.

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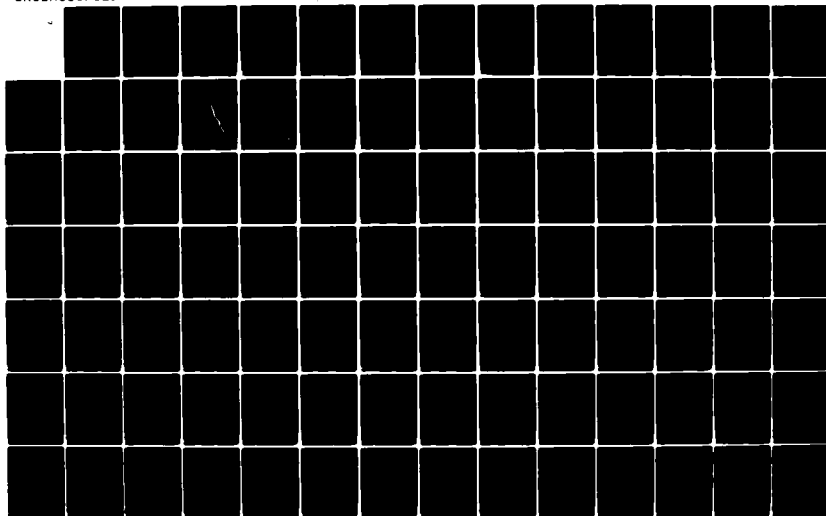
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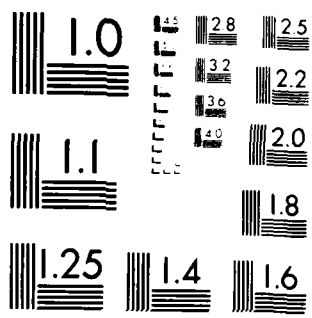
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MICROCOPY RESOLUTION TEST CHART
NATIONAL BUREAU OF STANDARDS-1963-A

FEBRUARY 24, 1981

Minutes from WESTNAVFACENGCOM - Exit Briefing

INTRODUCTION BY NORMAN STONES:

Norman Stones thanked everyone for their help, especially Robin Orans and Mark Herbach. He gave an overview of the trip explaining that the team was here to learn first hand from WESTDIV experience with EMCS and to listen to their recommendations. This knowledge should be dissiminated Navywide by NAVFAC and should be helpful with the design of the EMCS at Kings Bay.

OICC TRIDENT INVOLVEMENT WITH EMCS BY PETER WALMSLEY:

Pete Walmsley related Trident's history with EMCS at Subase Bangor. The original EMCS was not successful. An expansion study of the system showed it was more cost effective to replace the central portion of the original system than try to connect the expansion to it. This expansion is now in progress.

Rear Admiral Murray was familiar with the Bangor EMCS experience. He wanted assurances that the new EMCS system at the OICC Trident Sub Base at Kings Bay would work. He assigned the design team the task of visiting several EMCS installations and preparing a report to ascertain the probability of success for the new system. Then, if construction proceeded, to use this information to improve the system.

NAVFACENGCOM INVOLVEMENT BY SAM BRYSON:

Sam Bryson traced NAVFAC's involvement with the Interagency Guide Spec from its creation. The first Tri-Service Spec was the result of the failure of a very early and primitive EMCS at Pensacola Air Station in 1977. From this experience, two representatives from the Navy, the Army, and the Air Force met to create what would become known as the Tri-Service Spec and ultimately the Interagency Guide Spec. The spec has gone through many revisions and the first systems under the current spec are just now coming on line. There are 33 Navy projects in construction for a cost of approximately \$40,000,000. They are averaging one to three years behind schedule. NAVFAC is very concerned about these delays and accompanying problems. NAVFAC joined with Trident to help ascertain the status of EMCS and to find out what the problems are and to come up with suggestions for their solutions. Sam Bryson's conclusions so far are:

1. It takes about three years minimum to develop an EMCS system. All the contractors underestimated the size of the task. For example: already 200 manyears of programming time has been spent by Honeywell developing the software for the EMCS.
2. The contractors used government money to do R&D on EMCS. The EMCS systems were developed during the construction period.
3. New systems are very complicated. They do not lend themselves to the traditional brick and mortar type contracting or supervision methods.
4. The ROICC needs a source of technical help for him to successfully administer the contracts.
5. The user must be convinced that the system is there to help him. He must be interested and motivated to make the system work.

SITE VISITS AND PRELIMINARY FINDINGS BY STEVE BRUNING:

Steve Bruning asked the basic questions that this group was trying to answer for Kings Bay: Should Kings Bay have an EMCS? If they should, what configuration should it be? What problems areas from the past can we avoid?

To help answer these questions, the team has visited several areas in WESTDIV. Detailed meeting notes will be prepared and sent to WESTDIV people who accompanied the team for review, modification, or comments.

The three WESTDIV areas visited were the Seattle area, the San Francisco Bay area, and the San Diego area. In the Seattle area the team saw the Bangor Submarine Base, the Puget Sound Naval Shipyard, and the Bremerton Naval Regional Medical Center.

The Bangor Submarine Base EMCS is non-operational, but is being rebuilt as a part of a major expansion.

The Puget Sound Naval Shipyard is operational.

The Bremerton Naval Regional Medical Center has a Honeywell EMCS that is operational and a Compugard fire/security system that is intermittently operational.

In the San Francisco Bay area the team visited the NARF at Alameda, and the Mare Island Shipyard.

The NARF at Alameda is a Johnson system that is under construction. They are experiencing software delivery delays.

The Mare Island Navy Shipyard is an Oak Adec system. It is one year behind schedule and awaiting software. They expect a startup date in three to six months.

In the San Diego area the team visited or interviewed key personnel from the following sites:

- Public Works Centers - San Diego
- North Island Naval Air Station
- Navy Oceans Systems Center
- Point Mugu
- Long Beach Navy Regional Medical Center
- Camp Pendleton
- Camp Pendleton Hospital

The San Diego Public Works Center system is not operational. It is a Radix 4000 system. Currently contract negotiation underway to obtain adequate documentation.

The North Island system is operational. The EMCS software is by EMS and the equipment is from Balboa Systems. The user is very pleased with the system. They are currently doing only the monitor functions and will phase over to full EMCS control as they get customer acceptance of the system.

Navy Oceans Systems Center is a Burns monitoring system. Its principal duties are leak detection. The user indicated that it was operational, but had not been accepted yet.

The Point Mugu system is from AEA. There are contractual debates on the contract requirements.

The Long Beach system has been accepted and is operational, but the customer does not consider it adequate. It is a Radix system. They are also experiencing documentation problems.

Camp Pendleton's Honeywell system has been operational for some time and is in its fourth expansion. The system was initially a manpower reduction system but has been upgraded into a full EMCS. The customer is very happy with the performance.

Camp Pendleton Hospital. This is an old Powers system. It has performed adequately, but is now having maintenance problems. This system is expected to be updated soon.

Common Conclusions:

PLANNING

1. The activities need to be involved from the first day of planning. Activities will make or break the system.
2. Activities must plan for maintenance from the very beginning of the design stage. This will have a large impact on how the system is designed.

DESIGN PHASE

1. There is a need for more detailed field design and clear, concise functional definitions of which equipment is to be controlled and exactly how it is to be controlled.

PROCUREMENT

1. Some means of pre-qualification of the bidders is needed.
2. "Small-business-set-aside" forces the prime to be the electrical contractor and the EMCS equipment supplier to be the subcontractor. This moves technical expertise further away from the problems with the system.

CONSTRUCTION

1. The ROICC needs access to technical assistance.
2. The method of progress payments needs to be revamped to also reflect the importance of software, documentation and final acceptance testing.
3. There needs to be a Central Authority to give consistent interpretation of the Tri-Service specification.

OPERATIONS

1. Staffing: The problem of staffing has not been adequately resolved. The system operator should have a Mechanical Engineering background and use the EMCS as one of his tools in control of energy on base.
2. Training: The training should be periodic and on going. There will be a recurring need to train new

operators, and to improve the overall proficiency of the staff.

3. Maintenance: The effort required to maintain an EMCS is substantial and on going.

KINGS BAY COMMUNICATIONS STUDY

Site Visit Notes

Disney World
Lake Buena Vista, Fla.
Jan 7, 1981

Attendees:	Gardner Chambliss	Newcomb & Boyd
	Pete Walmsley	Trident East
	Dick Winn	Engineering Associates
	Mike Fleming	NAVFACHQ
	Gary Harkcom	NAVFACHQ

The Energy Monitoring and Control System at Walt Disney World includes approximately 232 control points with feedback. They are divided into two groups. The Magic Kingdom with 128 points and the north Service Area with 104 points. The central equipment is located in the Theme Park area in the Digital Animation Control System (DACS) Rooms and use's much of the same technology as the DACS.

The initial reaction at Walt Disney World Vacation Kingdom to the 1974 energy crunch closely paralleled the general response of industry at that time. A committee was immediately formed from operating management personnel to identify and implement conservation programs, such as resetting thermostats, reducing lighting, turning off HVAC systems and lighting when not needed. These operational changes were emphasized because they were immediately effective and could be implemented with limited capital expenditure.

It became quickly evident, however, that a longer term, strategic plan of energy management was needed to cope with complexities of the operating systems involved. For example, time clocks were initially used to affect the on/off control of lighting and HVAC systems. These worked and did save energy; however, they introduced new operational complications and costs associated with resetting the clocks to accommodate the many special events and changing operating hours in the Theme Park. Also, there were instances where the controls were set improperly.

An Energy Management Committee was then formed which included representatives from Engineering, Maintenance, and Utilities, as well as Operating personnel from Theme Park. Lake Buena Vista Communities, and the Resorts. This committee has been very effective in identifying, evaluating, and implementing energy conservation projects. It is a continuing entity and is presently chaired by the Energy Conservation Manager at Walt Disney World. Projects range from the computer controlled lighting and HVAC system to hot water generation from refrigeration units and air curtains at the Contemporary Hotel monorail entrances to name a few.

One of the committee's first efforts was to expand the concept of a centralized control system to operate lighting and HVAC systems on property. This was a comfortable concept for a management who pioneered operation of its shows from a centralized Digital Animation Control System (DACS) in the Magic Kingdom. DACS signals are transmitted to all shows in the Theme Park to operate the equipment, lights, and music. This facility also houses the Automatic Monitoring and Control System (AM&CS) which continually checks fire and security alarm points and key operating/maintenance variables, such as waste water lift station levels, critical bearing temperatures, and abnormal operation of all freezers and refrigerators. DACS Central is manned/supervised on a 24 hour basis from a display/control console. Here the dispatcher can receive or transmit maintenance trouble messages to field personnel via telephone or radio communications. DACS Central thus functions as an operation command/control post for maintenance at Walt Disney World.

The basic control hardware concepts to implement a centralized computer control of all large HVAC systems and lighting circuits in the Theme Park was already in place, and the required signal lines back to DACS Central were also available, due to an existing common use cable system. A computer was available to effect the control logic.

The flexibility offered by computer control allowed the committee to expand the original concept of simply turning off the equipment/lighting after hours to one with feedback control logic.

It was felt that a simple digital only system should be used. This type system, using the existing computer and communication lines, would cost only about 10% of the cost of a full EMCS and return 85% of the savings.

Accordingly, a program for cycling the air handler units for energy savings was included. Most of the AHU drive motors are rated about 50 HP which makes them good candidates for load shedding control. The program logic also permits resets in the cycle period to reflect ambient and operational changes.

This expanded concept of HVAC control, however, precipitated some operation concern. Management wanted assurances that guest comfort conditions would not be compromised and that the rate of return (ROR) on the project investment would be economically attractive. Maintenance personnel in turn were concerned with possible problems which might be introduced by cycling the large rotating machinery. It was concluded that these questions could only be resolved by a pilot program.

Three major AHU's serving the basic types of Theme Park activities (employee, show, and merchandise) were selected and equipped with prototype controls. Instrumentation was installed to record Chilled Water (CHW) and High Temperature Hot Water (HTHW) consumption and to monitor key mechanical equipment components which could wear excessively or fail due to increased physical stress under cyclical operation. These data were augmented by scheduled field observations and measurements. Concurrently, the temperature and relative humidity of the conditioned areas were recorded on a 24 hour basis.

Initially, each prototype installation was monitored under existing conditions to establish a set of normal data. A prototype computer program was then used to establish a cycling off/on mode during Theme Park operating hours and after hours which did not compromise the comfort conditions and show requirements of the areas being served.

In case of the merchandise activity, which was typified by open door on several sides of the building for unobstructed guest entry and exit, it was infeasible to cycle the system during operating hours. The other two tests, in employee and show areas, indicated it was possible to cycle the units a maximum of three times per hour at a 20% off period during operating hours. Further units serving the show and merchandise facilities could be programmed off after-hours; several employee locations could not, due to the 24 hour operational requirements.

The data from these tests confirmed that programmed control was feasible and would effect appreciable savings in energy. In addition, the anticipated increase in maintenance costs appeared to be much less than expected. The subsequent economic analysis showed a ROR of over 300% and the project was approved and installed.

The Energy Management System (EMS) terminal is located at the DACS operator's console. The Computer and remote HO-A switches are located in the DACS Computer Room.

The control system uses a 48 D.C. signal which is switched by the computer to operate a relay in the auto position of the motor control center. In addition to securing the AHU's, the signal also turns off the CHW and HTHW flow in the heat exchanger coils. The control loop was closed by a feedback signal from a sensor which detected air pressure in the duct system. This feedback signal is checked one minute after the control signal is sent.

The savings effected in these systems is reflected in the operation of the Central Energy Plant (CEP) where primary savings in load shedding and energy is accomplished by securing the large water chillers. In Winter, energy savings are accomplished in HTHW system which in turn effects fuel cost savings.

There has been a 10.6 and 15.1% decrease in total annual energy consumption of CHW and HTHW respectively. When these savings were extended to dollars, using marginal energy costs experienced in 1977, they amounted to over \$1 million a year in savings.

The initial EMS, which included 91 AHU's in the Theme Park, is continually being expanded. All Theme Park lighting is now being controlled from DACS Central via a separate control system. The HVAC control system has been extended to the North Service Area and to Lake Buena Vista properties, a distance of about eight miles, by using a multiplex modem system. This is a frequency multiplexer which permits two-way communications with the computer over a single pair of wires.

Probably one of the most important factors of the singular success of the EMS at Walt Disney World was the fact that it has been conceived, designed, installed, programmed, and maintained by on-site personnel and that management was committed to its success. The committee ensured that all responsible for its operation were consulted and contributed to the concept so it became their system. Also, the computer program was designed for the system, reflecting the operating requirements identified during the prototype tests. This contrasts with some of the more typical EMS where a "canned" program is purchased and then modifications are attempted to make it fit the specific needs of the given system.

APPENDIX B - SITE VISIT ATTACHMENTS

1. Western Washington University
2. Honeywell
3. NESO Report
4. PWC San Diego
5. Naval Ocean Systems Center
6. Camp Pendleton
7. AEA

COST AVOIDED THROUGH ENERGY CONSERVATION

NATURAL GAS

MAIN CAMPUS

1973-1974 THRU 1979-1980

Projected Cost=Cost if efficiency remained at same level as 1973-1974.

Degree days and average rates per each year taken into account.

<u>YEAR</u>	<u>PROJECTED COST</u>	<u>ACTUAL COST</u>	<u>DIFFERENCE DUE TO CONSERVATION</u>
1973-1974	\$215,526	\$215,526	-0-
1974-1975	\$340,101	\$302,745	\$ 37,356
1975-1976	\$424,367	\$373,752	\$ 50,615
1976-1977	\$500,758	\$380,368	\$120,390
1977-1978	\$560,242	\$403,943	\$156,299
1978-1979	\$713,027	\$494,551	\$218,476
1979-1980	<u>\$874,723</u>	<u>\$565,949</u>	<u>\$308,774</u>
	\$3,628,744	\$2,736,834	\$891,910

*****COST AVOIDED THRU CONSERVATION \$891,910

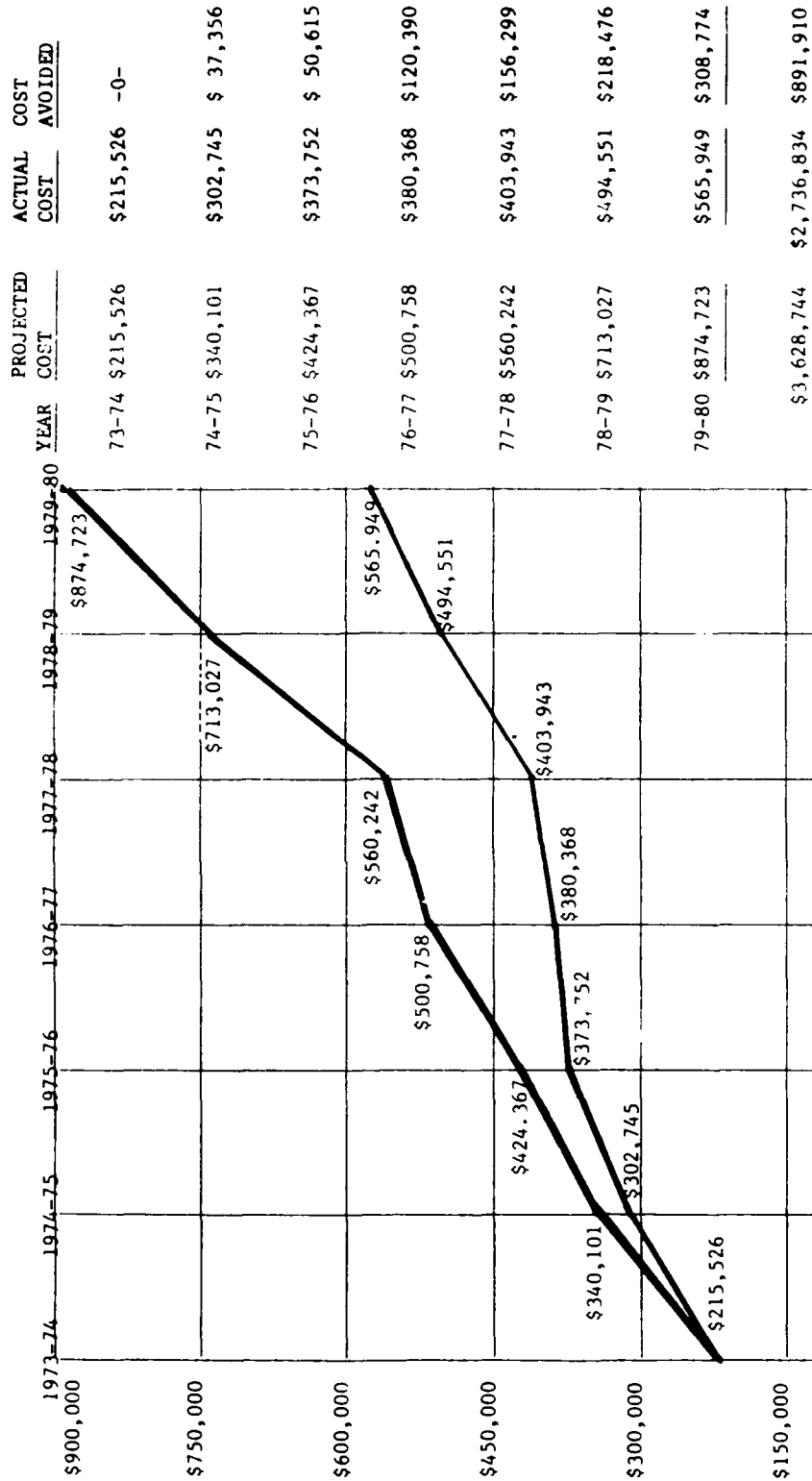
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Attachment ①

NATURAL GAS
EFFECT OF CONSERVATION ON NATURAL GAS BILL

— PROJECTED
 — ACTUAL



*****COST AVOIDED THRU CONSERVATION
 \$891,910

COST AVOIDED THROUGH ENERGY CONSERVATION

NATURAL GAS AND ELECTRICITY

MAIN CAMPUS

1973-1974 THRU 1979-1980

Projected Cost=Cost if efficiency remained at same level as 1973-1974.

Degree days and average rates per each year taken into account.

<u>YEAR</u>	<u>PROJECTED COST</u>	<u>ACTUAL COST</u>	<u>COST AVOIDED</u>
1973-1974	\$ 360,834	\$ 360,834	-0-
1974-1975	\$ 519,405	\$ 477,603	\$ 41,802
1975-1976	\$ 613,153	\$ 562,002	\$ 51,151
1976-1977	\$ 734,112	\$ 613,722	\$ 120,390
1977-1978	\$ 807,251	\$ 648,327	\$ 158,924
1978-1979	\$ 977,680	\$ 750,418	\$ 227,262
1979-1980	<u>\$ 1,229,358</u>	<u>\$ 882,628</u>	<u>\$ 346,730</u>
	\$ 5,241,793	\$ 4,295,534	\$ 946,259

*****COST AVOIDED THRU CONSERVATION \$946,259

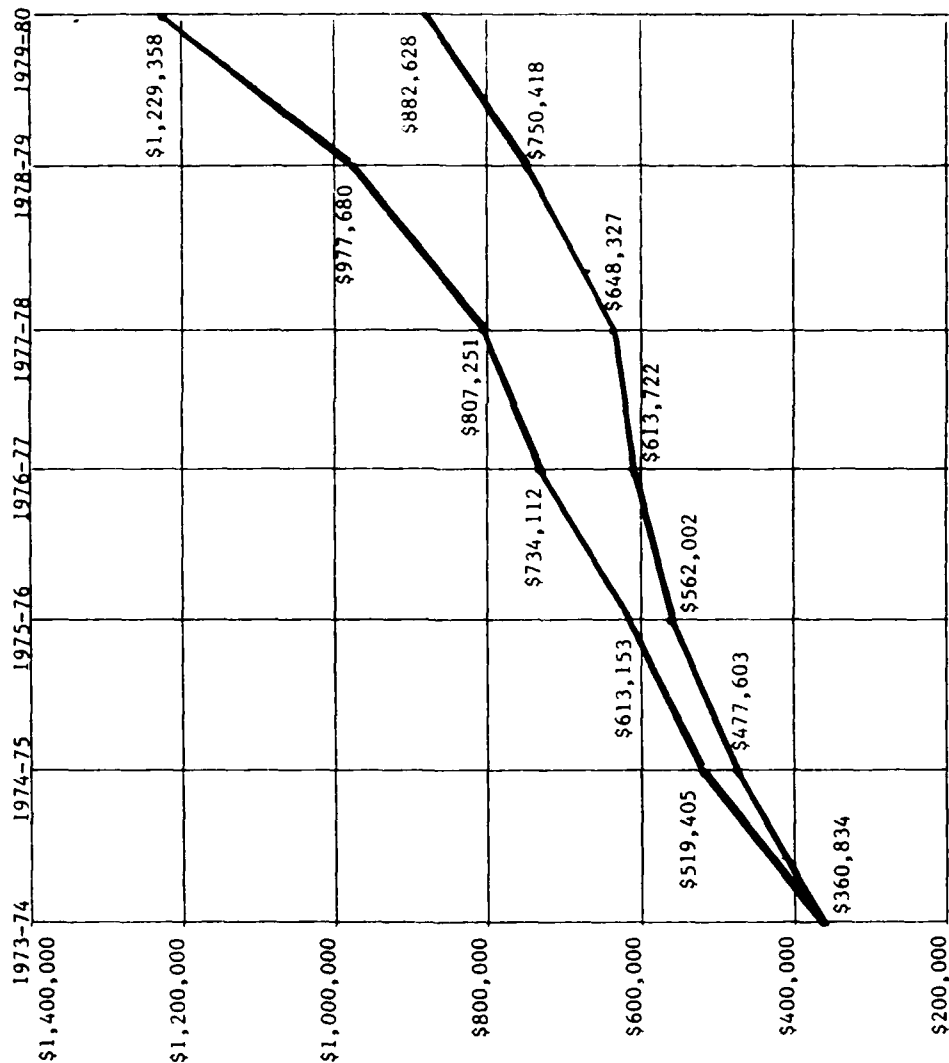
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EFFECT OF CONSERVATION ON ENERGY BILL
NATURAL GAS AND ELECTRICITY
1973-1974 THRU 1979-1980

①

YEAR	PROJECTED COST	ACTUAL COST	COST AVOIDED
73-74	\$360,834	\$360,834	-0-
74-75	\$519,405	\$477,603	\$ 41,802
75-76	\$613,153	\$562,002	\$ 51,151
76-77	\$734,112	\$613,722	\$120,390
77-78	\$807,251	\$648,327	\$158,924
78-79	\$977,680	\$750,418	\$227,262
79-80	\$1,229,358	\$882,628	\$346,730
	\$5,241,793	\$4,295,534	\$946,259

*****COST AVOIDED THRU CONSERVATION
\$946,259



COST AVOIDED THROUGH ENERGY CONSERVATION

ELECTRICITY

MAIN CAMPUS

1973-1974 THRU 1979-1980

Projected Cost=Cost if we had consumed electricity at same rate as 1973-1974-
(7.71 KWH/SQ.FT.) Average rate in effect each year is used.

<u>YEAR</u>	<u>PROJECTED COST</u>	<u>ACTUAL COST</u>	<u>COST AVOIDED</u>
1973-1974	\$ 145,308	\$ 145,308	-0-
1974-1975	\$ 179,304	\$ 174,869	\$ 4,435
1975-1976	\$ 188,786	\$ 188,250	\$ 536
1976-1977	\$ 233,354	\$ 233,354	-0-
1977-1978	\$ 247,009	\$ 244,384	\$ 2,625
1978-1979	\$ 264,653	\$ 255,861	\$ 8,792
1979-1980	<u>\$ 354,635</u>	<u>\$ 316,678</u>	<u>\$ 37,957</u>
	\$1,613,049	\$1,558,704	\$54,345

*****COST AVOIDED THRU CONSERVATION \$54,345

7-80

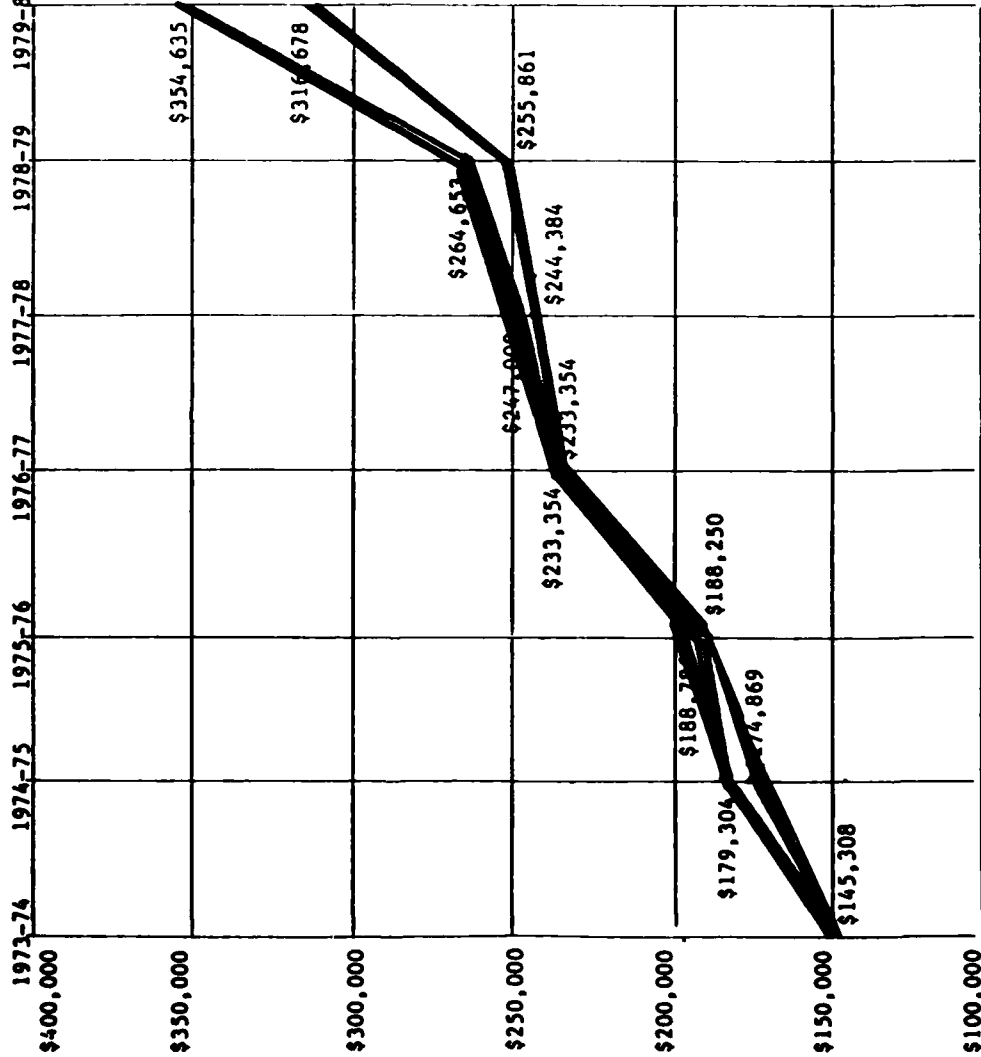
**ELECTRICITY (KWH)
EFFECT OF CONSERVATION ON ELECTRICITY BILL**

**PROJECTED
ACTUAL**

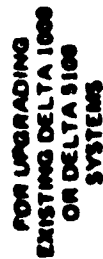
①

YEAR	PROJECTED COST	ACTUAL COST	COST AVOIDED
1973-74			
1974-75			
1975-76			
1976-77			
1977-78			
1978-79			
1979-80			
73-74	\$145,308	\$145,308	-0-
74-75	\$179,304	\$174,869	\$ 4,435
75-76	\$188,786	\$188,250	\$ 536
76-77	\$233,354	\$233,354	-0-
77-78	\$247,009	\$244,384	\$ 2,625
78-79	\$264,653	\$255,861	\$ 8,792
79-80	\$354,635	\$316,678	\$37,957
	\$1,613,049	\$1,558,704	\$54,345

*****COST AVOIDED THRU CONSERVATION
\$54,345



Program Development



**FOR UPGRADING
EXISTING DELTA
OZONE INSTALLATIONS**

HONEYWELL
AND THE
TRI-SERVICE SPECIFICATION

ARLINGTON HEIGHTS

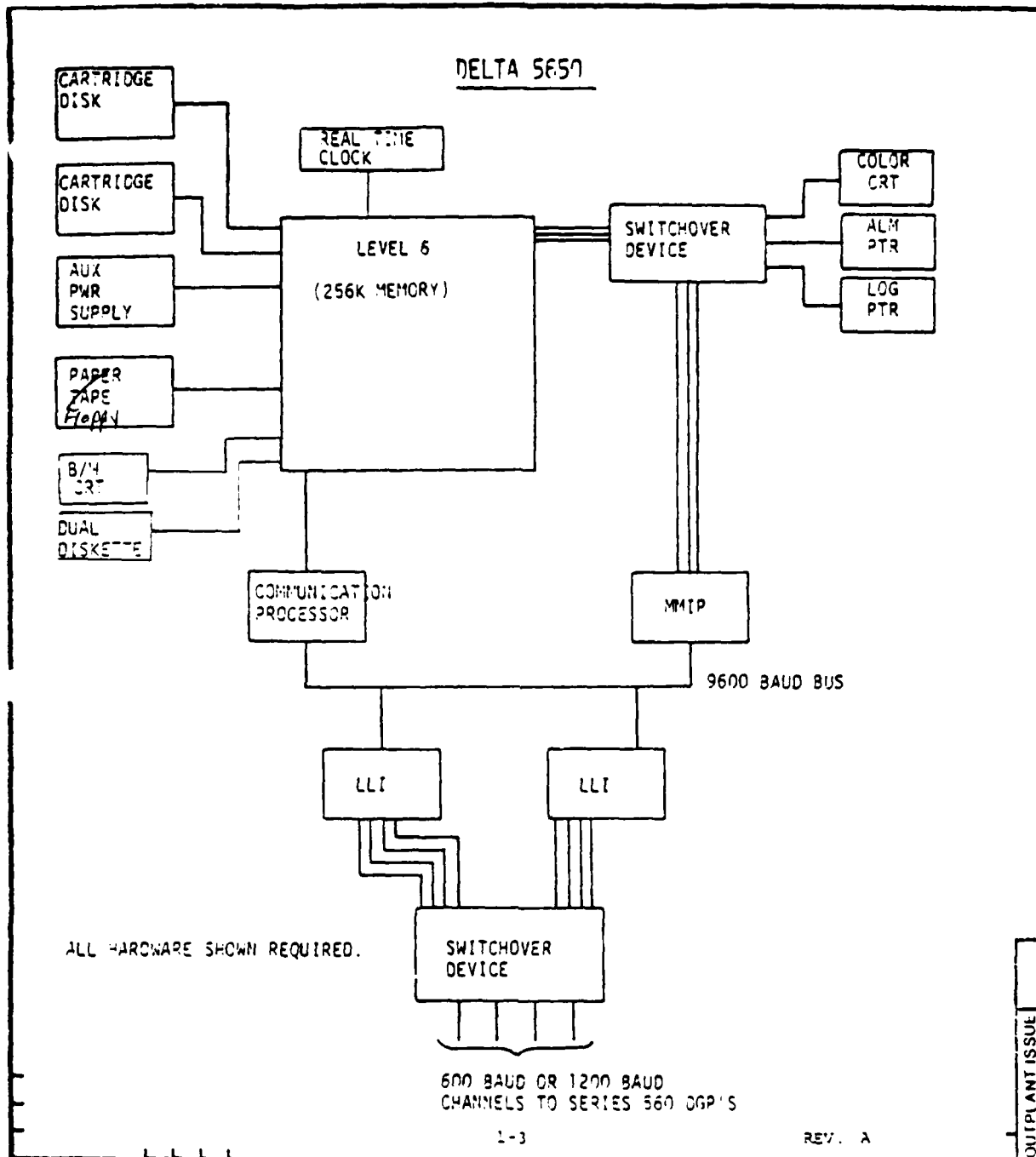
JAN. 26, 1981

0700	DEPART CONRAD HILTON	
0900	ARRIVE-HONEYWELL-WELCOME	H. BYNUM
0915	OPEN DISCUSSION-KINGS BAY COMMUNICATIONS	W. NEWCOMBE
1015	COFFEE	
1030	DELTA 5650 OVERVIEW	L. DRESSEL
1115	DELTA 5650 LAB TOUR	L. DRESSEL
1200	LUNCH-IN HOUSE	
1245	FACTORY TOUR	J. PELKEY
1330	TECHNOLOGY REVIEW	G. SHAVIT
1400	SPECIFICATION DISCUSSION	H. BYNUM
1615	DEPART HONEYWELL	

HONEYWELL HOSTS:

HARRIS BYNUM-ATLANTA-REGIONAL AUTOMATION SPECIALIST
JAY DOWDLE-MINNEAPOLIS-MARKET SALES MGR., FED. GOVT.
LARRY DRESSEL-MINNEAPOLIS-MARKET SUPERVISOR-DELTA 5650
DOYLE ADAMS-MINNEAPOLIS-NATIONAL SALES MANAGER
ROGER FEULNER-ARLINGTON HEIGHTS-DIRECTOR OF ENGINEERING
DON McNALLEY-ARLINGTON HEIGHTS-SUPERVISOR-SOFTWARE DEVELOPMENT
BILL NEWCOMBE-ARLINGTON HEIGHTS-PRINCIPAL SYSTEMS ENGINEER
DR. GIDEON SHAVIT-ARLINGTON HEIGHTS-SUPERVISOR-ADVANCED ENGR.
JAY PELKEY-ARLINGTON HEIGHTS-SUPERVISOR-PRODUCTION ENGINEERING

BOB STUGGS



PROJECT NO.				O.S. NO USED ON:				Honeywell <small>COMMERCIAL DIV. 400 N. 1ST ST. L. 504</small>			
DES	PROC	EVAL	QA	OWN	CHK	NAME					
						EXP. NO.					
						DWG. NO.					
REV	REVISION DESCRIPTION				DATE	P.C.O. NO.	A SIZE	SHEET	OF	REV	

OUTPLANT ISSUE

2

Do not Quote

SPEC OBJECTIVES - MANY

FIELD PROGRAMMABLE
HIGH LEVEL STANDARD LANGUAGE
COMPETITIVE ADDS ASCII RS232C
MORE SOPHISTICATED SOFTWARE (EMS)
CLMI-HELP-PROMPTING-INTERACTIVE
MORE STATE-OF-THE ART
FORTRAN
GENERAL PURPOSE MINI
MOVING HEAD DISC
DISTRIBUTED PROCESSING
INTELLIGENT DATA GATHERING PANELS
LOWER COST (OVERHEADS)

SPEC RESULTS:

VERY COMPLICATED SPEC

PDP 11/34

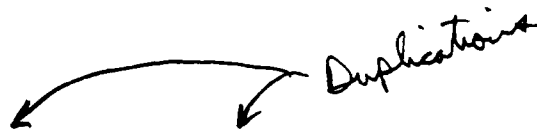
FORTRAN

NOT TOO CLEAR

IDGP (IQ=0)

NO PRODUCT DEVELOPED TO BID

TRADITIONAL CONSULTANTS HANDS TIED



PERIODIC CONTROL SEQUENCE + TIME PROGRAM FUNCTIONS

CYCLING CONTROL SEQUENCE + DUTY CYCLE PROGRAM

OVERRIDE CONTROL SEQUENCE + SOFTWARE INTERLOCKING SEQUENCE

ALGORITHMIC COOLING TOWER CONTROL + CONDENSER WATER TEMPERATURE CONTROL

CHILLER ALGORITHMIC CONTROL + CHILLER PLANT OPTIMIZATION



THE NEW SPEC:

12.4.4 Graphics Software: Provide graphics software fully implemented and operational to accomplish the following:

- a. Generate curves from mathematical equations - *why?*
- b. Generate horizontal and vertical bar graphs - *get links - no definition*
- c. Plot trend data by automatic incremental point movement - *not adequately defined*
- d. Address and plot individual points

1A
FINAL REVIEW DRAFT
(LARGE)

CONTRACT RESULTS:

EVERY JOB IS R & D -- DESIGN AND BUILD

SOFTWARE VERY UNDERESTIMATED -
TIME, COMPLEXITY, COST

NO VENDOR QUALIFICATIONS

UNREALISTIC COMPLETION TIME

MINIMUM ACCEPTABLE HARDWARE WILL NOT
SUPPORT SPECIFIED SOFTWARE

BIDDERS NEW TO CONSTRUCTION CONTRACTING

ELECTRICAL CONTRACTORS

+

SOFTWARE HOUSE

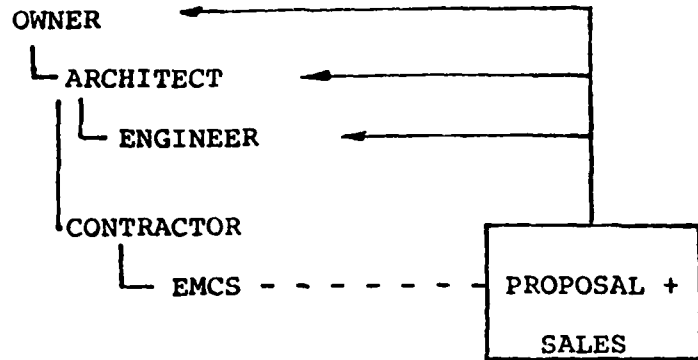
*Because nothing was
available when
spec developed*

*memory too
small, processor
too slow - too
much software
done in central -
128K in spec - 32K
user = 96K = too
small.*

FORTUNE 500

CONCERNS

TRADITIONAL



*FAA did it
this way?*

TRACK RECORD

LOCAL SUPPORT---FOREVER

SPARE PARTS

TRAINED TECHNICIANS

PROTOCOL

PROCESS - HVAC

SENSORS

TEST EQUIPMENT

TRAINING FACILITIES

TRAINING MATERIALS

QUALITY, PROVEN DOCUMENTATION

CODE APPROVAL

VALUE vs COST (LIFE CYCLE-STAFF)

STANDARD SYSTEMS

FUNCTION-ENGLISH-RELIABILITY-RESPONSE

PROBLEMS

USER TRANSITION

LIST
QUALIFIED
BIDDERS
PRIOR
APPROVAL

SUGGESTIONS

FOR

SUCCESS

1. DO NOT MAKE AWARDS TO
UNQUALIFIED BIDDERS

FAA 3 to 2

NIEHS *National Institute of Environmental Health Service*

EPCOT 8 to 4

VANDERBILT U.

UTMC - *Chattanooga*

REQUIRE PREBID PROPOSALS - IN DETAIL

SUCCESSFUL EXPERIENCE

SATISFACTORY SYSTEM

MATURE SOFTWARE

CLM

LOGS

DISPLAYS

EMA PARAMETERS

RESPONSE

DISPLAY

REPORT-ALARM

software
"STANDARDS" MIGHT WORK ON TIME

ENCOURAGE TRADITIONAL VENDORS

ASSURE THE SPEC DEFINES WHAT YOU WANT

USE EXPERIENCED CONSULTANTS AND GIVE THEM
RESPONSIBILITY

check on Ft. Meade

45600 380,000 lines of code

INVOLVE THE USER
SPEC INFLUENCE
DATA FILE SET-UP
APPLICATION PARAMETERS
BE EXTREMELY CAREFUL WITH SPEC EVOLUTION ← *x: medium and small system specs*
WATCH FOR TECHNOLOGICAL ADVANCES
AVOID LEADING TECHNOLOGY
BE TOUGH

Lack of Follow Up -

Hazell "Get off the job as soon as possible"
no one there to follow thru with owner

Date: September 5, 1980
To: BSM's
From: Harris Bynum - GA20-390
Location: CCD
Subject:

cc: BCM's
J. Vitelli-MN27-7246
R. Feulner-IL10
P. Egan-MN27-7246
J. Atkins-GA20
R. Henderson-CA30
D. Foesch-MN13-1104
H. Blair-NY73
S. Bowen-PA60

Gentlemen:

In computerized automation, software is where our investment dollars go, it's where our system performance lies, and it's the product we're selling.

Our success in selling the DELTA product lies partially in our understanding the world of programmers and software.

Attached is an interesting and relevant software article from the Sept. issue of Business Week. Several interesting facts that I have come to believe are stated:

- It takes three years or more to develop software.
- Programmers spend 80% of their time "maintaining" software developed in 20% of their time.
- Hardware doesn't solve customer problems, it drives problem solving software.
- It's not uncommon to develop \$200,000 worth in software to run on a \$10 chip.
- Creation of software is not like engineering, it's more like creation in the performing arts.
- Software takes an excruciatingly long time to get out the door...if you add more people, you're likely to slow down the process.
- Software estimates of time and cost are often off by 3 or 4 times.
- And finally, as with artists, managing the creative process of software development is no easy task.

All indications favor standard, field proven software.

As computer applications continue to expand, let's continue to talk standard software to our customers.



Attachment

Harris
da

B-18

②

27A1106:cc
4130:2130
Ser 010
06 JAN 1981

From: Officer in Charge
To: Commander, Naval Facilities Engineering Command (11)

Subj: Advanced-Technology Programs; executive summary of

Encl: (1) Acquisition and Subsequent Operation and Maintenance of Advanced-Technology Environmental and Energy Conservation Facilities, An Evaluation

1. Enclosure (1) contains results of the Naval Energy and Environmental Support Activity (NEESA) evaluation of Navywide energy monitoring and control systems (EMCS). Problems identified in EMCS programs are commonly found in other advanced-technology programs such as:

- a. First generation industrial waste treatment plants (IWTP),
- b. Energy monitoring and control systems (EMCS),
- c. Coal conversion of power plants/electrostatic precipitators (CCPP/ESP),
- d. Second generation IWTPs, and
- e. Oily waste/waste oil management facilities (OW/WO).

2. The significant findings and conclusions in enclosure (1) are:

a. The major problems in acquisition and operation of advanced-technology facilities include: deficient design; inadequate inspection and premature acceptance of facilities; time delays in project completion; poor or untimely feedback on construction, operation and maintenance of the facilities; staffing and training problems, and lack of accountability.

b. Responsibilities for monitoring the development of advanced-technology facilities from conceptualization to operational fruition are not vested in a single-point manager.

c. More than 90% of expenditures for advanced-technology facilities are scheduled for FY-81 or beyond. Many of the scheduled facilities are well into the planning and acquisition process.

3. Recommendations:

a. Develop and implement an advanced-technology management control (feedback) system that addresses problem areas identified in paragraph 2.d.

22A:WJC:co
4130:2100
Ser 012
06 JAN 1981

b. Designate a single program manager at Naval Facilities Engineering Command (NAVFACENGCOM) with appropriate authority, responsibility and accountability (to the chief) for each advanced-technology program.

c. Allocate programmed expenditures to a limited but representative, number of pilot projects for each advanced-technology program. Adjust the acquisition schedule based on the results of the pilot projects as well as the program requirements. Include lessons from current programs such as EMCS and second generation IATPs as appropriate in schedule adjustments for other advanced-technology programs.

2. For additional information regarding this evaluation, contact Mr. Bill Gleason, AUTOVON 300-4054, FTS 799-4054, or Commercial 305-984-4054.

JOHN P. COLLINS
By direction

Copy to:
COMNAVFACENGCOM (111/112)
NORTHNAVFACENGCOM (11)
CHESNAVFACENGCOM (10)
LANTNAVFACENGCOM (11)
SOUTHNAVFACENGCOM (11)
WESTNAVFACENGCOM (11)
PACNAVFACENGCOM (11)

Copy toP (w/o encl)
R/F
SON (3)
22EA
22A

- O
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E
6. Lacks a single project manager--current method is compartmentalized, i.e., not managed as an integrated system..
 7. Nine different types of funding identified.
 8. If problems arise individuals do not know where to obtain help.
 9. Need clear definition of role to all other organizations.
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10. Staffing and training requirements are not identified.
 11. Insufficient billets.
 12. High personnel turnover is common.
 13. ROICC, EFD, and activity often lack expertise/experience.
 14. If billets are available, do not know who to hire (electrical engineer, computer operator/programmer, or shop personnel).
 15. Do not know how to train.
 16. Often expected to be a collateral duty by the activity personnel particularly when the system is under construction.
 17. Technical expertise exists.

- E
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18. Program, plan, and budget
 - (a) 13 systems valued at approximately \$6.5M accepted by Navy.
 - (b) 32 systems valued at approximately \$35.8M under construction.
 - (c) 21 systems valued at approximately \$29.2M under design or planned.
 19. Funded approximately \$1 million for 17 feasibility studies.
 20. 17 feasibility studies initiated; 13 completed.
 21. Design and acquire:
 - (a) 13 systems accepted by Navy: Construction Management System (CMS) indicates only 5 of the 13 projects were 6 months behind scheduled completion date; however, EFDs state that 8 of the 13 were 6 or more months late. Five of these 13 systems had a cost increase of 7% or more above the original estimate. Average cost of these systems is about \$500,000.
 - (b) 32 systems currently under construction; 20 (62%) of these systems are projecting a schedule slip of 6 months or more and 17 (53%) are projecting a schedule slip of 12 months or more. 11 (34%) of these systems are projecting a cost growth of 7% or more above the original planning estimate. Average cost of these units is about \$1.1 million.

- (c) 21 systems under design or in planning have a projected cost of \$29 million and an average cost of \$1.4 million.
22. Premature acceptance by ROICC causes O&M problems.
23. Initial tri-service specification published in late 1977. No tri-service specification EMCS is fully operational as of Sep 1980. Navy policy regarding the tri-service specification and the expansion of existing Navy EMCS is controversial because competing systems currently are not fully compatible.
24. Elements of a good operational EMCS are: good hardware, dedicated personnel, comprehensive documentation, top management support, comprehensive training, good maintenance, and management feedback.
25. 13 EMCSs installed and accepted by Navy activities: Activities or EFDs report that 11 (85%), representing 57.5% of the total dollar value of these 13 units that have been accepted are operating. Of these 9, representing 47.3% of the total dollar value of these units are "fully operational."
- Of the two units labeled operating but not fully operational, one unit has staffing problems. The other appears to have hardware, software, firmware, and staffing problems. Of the two units accepted but not operating, one has been labeled a "design and construction mistake" and the other has no operational software.
26. Activity personnel the majority of who are involved with EMCS for the first time, predict staffing and training problems.
27. Activity personnel indicate that they do not fully participate in the EMCS planning process.
28. NRMC Long Beach, CA, retrofit; premetering at Pacific Missile Test Center, Point Mugu, CA, and at Amphibious Base Little Creek are in progress. Lessons learned and technology transfer are planned.
29. DEIS-II, ECR, EAR and tri-service specification are in place but provide insufficient feedback mechanisms to evaluate actual EMCS performance. Management lacks a meaningful information system that will allow an evaluation of EMCS performance; i.e., Btu's saved per dollar expended. (This is an open loop in the management process.) NAVFAC policy regarding the tri-service specification is controversial for use in expanding existing EMCS systems. The fact that there are no fully operational tri-service specification systems 3 years after its initial publication suggests problems either with the specification or with its implementation.

- C 30. Pre- and post-EMCS project metering on a statistically valid basis is
O not required; therefore, meaningful feedback is reduced or eliminated.
- N 31. The many delays with EMCSs under construction suggest problems requiring
T corrective actions by NAVFAC. Problems with EMCS are not limited to
R the Navy. An article in the ASHRAE Journal indicates 70% of EMCS at
O colleges and universities may be inoperative. A major study to identify
L causes of problems was commissioned by the Veterans Administration.
The study reveals that equipment is reasonably reliable, but operators
who lack training are intimidated by system complexity.
32. Untimely feedback.

ANALYSIS OF TABLE I: Figure 1 is a pictorial representation of the management process described in table I. To place the Navy's EMCS management process into perspective, those agencies involved in these projects should review procedures at each of the blocks indicated. The dominant result desired by the Navy is that activities operate and maintain EMCSs effectively and efficiently to save energy. Information obtained in preparation of this evaluation indicates that most Navy activities do not know if this EMCS criteria is being met. This is true because activities lack operating experience, and there is no pre- or post-metering data available to measure against. Only 3 of the 12 activities accepting an EMCS were known to have produced engineering calculations in an attempt to validate energy savings; these activities have not provided feedback to compare actual savings with those projected during submissions of the 1301 or 11004. An activity that does not know its energy savings cannot tell the EFD, and the EFD cannot tell NAVFAC. Therefore, actual energy to cost ratio (E/C) for EMCSs remains unknown, obviating NAVFAC programming adjustments of EMCS projects based on solid data, so the systems keep coming.

The situation is complicated by a lack of staffing (billets) and by inadequate training policies for EMCS operators/managers at the Navy activities, major claimants, NAVFAC, and EFDs. In addition, many Navy-contracted A&Es lack sufficient EMCS experience, particularly with digital logic. The 6% fee is considered too small to attract A&Es who could change this situation. Thus, many factors contribute to the problems in the management of these systems; however, no one seems to be in a position to correct them.

LINK BETWEEN EMCS, IWTPs AND ESPs:

It is noted that many similar problems were identified in an IWTP study completed by NESO in June 1978. In addition, the following problems have been identified by the NESO Air Team involving several electrostatic precipitator (ESP) installations at power plants:

- (a) Designed to outmoded specifications, resulting in inadequate or marginal performance. (Validation of requirements could eliminate the situation.)

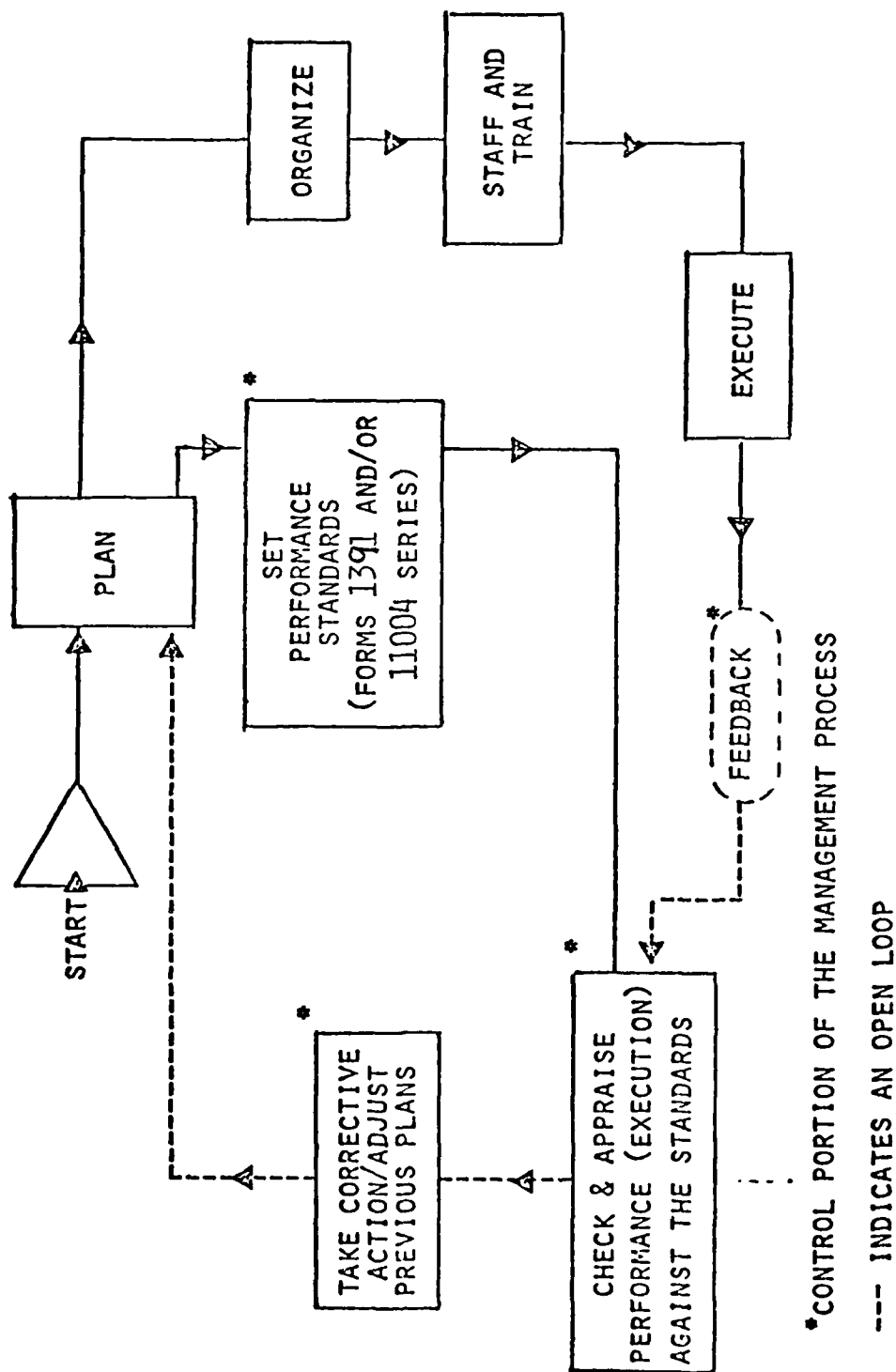


FIGURE 1, THE MANAGEMENT PROCESS FOR EMCS

- (b) Accepted by a ROICC not experienced in ESP constructing technology.
- (c) Maintained by inadequately trained personnel.
- (d) Not planned as a system.
- (e) Designed and constructed in an organization established for "brick and mortar" type projects. The current organization represents a compartmentalized approach to facilities design, acquisition, construction, operations, and maintenance rather than a weapons systems team approach.

Recent experience (Aug 80) by the NESO Air Team at a major Navy activity indicates that an ESP was designed and constructed without sufficient baseline data or attention to detail. Consequently, the questionable design (including outmoded ESP controls) coupled with poor construction has led to a failure to comply with legally mandated environmental standards at full rated loads. Initially, the ESP failed at most loads and only passed legal requirements after significant adjustments to the system. In addition, coal pulverizers may require replacement. The system in question was accepted by a ROICC who was not experienced in ESP technology. The result is another costly problem, which could have been averted if the project had been managed as a system, prior to initiating design and starting construction.

The link between IWTPs, ESPs, and EMCS appears to be "COMMON PROBLEMS" associated with the acquisition and subsequent operation and maintenance of new advanced-technology facilities.

ANALYSIS OF ESP SITUATION: The ESP industry was doing a relatively good job of meeting emission standards dictated by economics, community pressures or local codes, until passage of the Clean Air Act (CAA) in the early 70s.

In December 1971, new source performance standards for fine particulate emissions associated with CAA were promulgated at 0.1 pounds per million Btus. Nationwide acceptance of ESPs dropped to approximately 70%.

In September 1978, new source performance standards for fine particulate emissions were changed to 0.03 pounds per million Btus, and nationwide acceptance plummeted towards zero.

In 1979, with the advent of new designs, the ESP industry recovered and is again starting to do a creditable job. Regrettably, Navy design specifications are concentrating on ESP technology represented by pre-1978 technology. Technical manual No. 5-815-1 (NAVFAC Design Manual 3.15/Draft) illustrates this point. NEESA ltr ser 1202 of 18 Sep 80 applies. Thus, the Navy's organization has not responded to the rapid pace of technology change. The impending coal conversion program will require pollution abatement devices such as ESPs, and a procedure should be established for the expeditious transfer of lessons learned to Navywide users.

DIFFERENCES BETWEEN ENVIRONMENTAL AND ENERGY PROGRAMS

Equipment acquisitions associated with environmental programs are driven by legal mandates and require a feedback to demonstrate that compliance has been attained. Equipment acquisitions associated with the energy program are driven by economics and energy savings and similar feedback systems are not mandated.

A good feedback system (actual energy measurements before and after project completion) can be expensive and does not contribute directly to energy savings. Consequently, it is not "cost effective" and is usually not included or, if included, is subsequently dropped from energy conservation projects. Thus, most EMCS projects are being managed without operational feedback, creating an open loop in the management process. Feedback from pollution abatement projects is often late; i.e., discovered when the device will not perform its intended, legally mandated function or when the naval activity finds out that it is not able to operate or maintain it.

COST AND SCHEDULES FOR ADVANCED TECHNOLOGY PROGRAMS:

A review of costs and installation schedules indicates:

- (a) First generation IWTP costs are estimated at 50 million, and facilities are mostly installed.
- (b) EMCS estimated costs are \$72 million, and about 50% of the facilities are scheduled for installation in FY-81 and beyond.
- (c) Coal conversion of power plants, each of which has associated ESPs, baghouses, or scrubbers, have projected costs of \$713 million and are scheduled to be installed between FY-81 and FY-87.
- (d) Second generation IWTPs and source control systems have projected costs of \$75 million, and facilities are scheduled for FY-84 and beyond.
- (e) Oily waste and waste oil facilities have projected costs of \$100 million, and facilities are scheduled for installation FY-83-90.

It is recognized that many of these advanced-technology installations are well along into the planning and acquisition process; however, in terms of dollars, more than 90% of these facilities are scheduled for installation in FY-81 and beyond.

SUMMARY AND CONCLUSIONS:

- (a) The NAVFACENGCOM, EFDs, and Public Works groups are currently organized to design, acquire, operate, and maintain traditional facilities associated with traditional technology facilities. The requirements for advanced-technology facilities were largely initiated in the 70s, and these requirements were usually associated with pollution abatement and energy conservation projects. To date, the Navy's organization has not changed or recognized the need to change in order to manage its advanced-technology projects more effectively.
- (b) The common denominator between IWTPs, EMCS, or ESPs is that each represents an advanced-technology area new to the NAVFAC family and the Navy shore establishment. Each program appears to have similar problems. The Navy needs a fully integrated management approach for planning, requirement validation, acquisition, operation and maintenance of advanced-technology energy facilities. Closer coordination between the EFD, activity and major claimant at all phases of acquisition, operation, and maintenance is essential. Current management practices do not fully recognize the requirements for:

- integrated logistics support plans;
 - PERT charts;
 - definition of authority, responsibility, and accountability, including all interface relationships,
 - definition of staffing and training requirements,
 - additional post-acquisition support for activities,
 - timely control and feedback systems at all stages of acquisition, operation and maintenance of the facility.
- (c) In general, the Navy does not manage advanced-technology facilities from "cradle to grave."
- (d) The magnitude of these advanced-technology facilities is escalating at a rapid rate. In dollar terms, over 90% of the advanced-technology facilities considered in preparation of this document are scheduled to be installed in FY-81 and later. There is still time to take corrective action.
- (e) Advanced-technology projects have the following characteristics:
- (1) complex
 - (2) expensive
 - (3) unique
 - (4) lack of experienced personnel.

RECOMMENDATIONS:

1. Recommendation: Designate a single program manager at NAVFAC with appropriate authority, responsibility, and full accountability (to the chief) for each advanced-technology program.

Rationale: This individual would be responsible for managing each unique, expensive, and complex program as a complete system, including planning, acquisition, operational training, identifying staffing and maintenance requirements. The program manager would be responsible for rectifying the entire range of management deficiencies pinpointed in this report. It is envisioned that each program manager would assemble a team of experts accountable to him (including those with hands-on experience). The team would provide support to all levels of the EFD and the Navy activities. Lessons learned could be transferred within the Navy by the team in an expeditious manner; this would alleviate the problem of each EFD climbing its own learning curve regardless of the number of assigned projects. The single program manager would insure development of the NAVFAC/EFD/activity interface and thus minimize staffing and training problems. The program manager would be accountable for program's success, eliminating failures being "no one's fault," since no one is in charge.

2. Recommendation: Develop and implement an advanced-technology management control/feedback system that includes effectiveness and efficiency of actual operation and maintenance of the advanced-technology systems at a Navy facility.

Rationale: Numerous problems have been identified in the operation and maintenance of advanced-technology systems at Navy activities. However, these problems have been identified through efforts outside the normal NAVFAC reporting system. Lack of a feedback from the activity causes the entire NAVFAC management process to be running in an open loop. For energy projects, this feedback should include energy validation plans based on statistically valid identification of pre- and post-metering requirements.

3. Recommendation: Program, plan, budget, design and acquire a representative number of pilot projects for each advanced-technology program. Adjust the acquisition schedule based on the results of the pilot projects equated with program requirements. This adjustment should include current programs such as EMCS and second generation IWTPs as appropriate.

Rationale: If problems develop with any advanced-technology program, Navy management can react by dedicating additional assets to overcome them or by adjusting the acquisition schedule. This should eliminate the continuing to buy situation even when involved in a troubled program.

ACQUISITION AND SUBSEQUENT OPERATION AND MAINTENANCE OF ADVANCED-TECHNOLOGY ENVIRONMENTAL AND ENERGY CONSERVATION FACILITIES; AN EVALUATION

GENERAL BACKGROUND

The Navy has experienced difficulties in the acquisition and subsequent operation and maintenance of advanced technology systems related to the present state-of-the-art energy conservation and pollution abatement. Examples of advanced-technology systems include: industrial waste treatment plants (IWTPs), energy monitoring and control systems (EMCSs); electrostatic precipitators (ESPs), oily waste/waste oil (OW/WO) management facilities and the coal conversion of power plants (CCPPs).

In general, problems associated with advanced-technology system procurement cut across the entire management process (i.e., planning, organizing, staffing and training, executing, and controlling). Common problems include:

- deficient design,
- lack of an integrated logistics support plan,
- lack of single point accountability,
- poor construction,
- time delays in completion,
- inadequate inspection and premature or unjustified acceptance,
- inadequate staffing of the operational system,
- inadequate training of operators,
- poor or untimely feedback about system performance/reliability.

This report identifies management deficiencies in the procurement of advanced technology. The procurement of EMCS systems is used as an example of these deficiencies in advanced-technology project management.

EMCS BACKGROUND

The Navy's EMCS program is placed in perspective in table 1. This matrix shows organizations involved in the advanced-technology management process. Key or dominant comments, which have been provided by EFD and activity personnel, are indicated by numbers in the matrix and are summarized in "An Explanation of Matrix Numbers in Table 1." Their comments are worthy of consideration in that they provide a systems appraisal of EMCS projects.

~~ENCLOSURE (1)~~

(3)

TABLE I
NAVY ORGANIZATIONS AND THE EMCS MANAGEMENT PROCESS

← Organization →	→ Mgmt. Process →				
	Plan	Organize	Staff & Train	Execute	Control
FAC	1	6	10	18, 19, 20	29, 30, 31, 32
EFDs	1, 2, 3, 4	6	10, 11, 12 13	20, 21, 22, 23	30, 31, 32, 29
ACTIVITY	1, 2, 3, 4, 5	7, 8	10, 11, 13, 14, 15, 16	24, 25, 26 27, 28	30, 31, 32
R&D	1	9	17	28	32

AN EXPLANATION OF MATRIX NUMBERS IN TABLE I

- P
L
A
N
1. Planning lacks meaningful feedback or a means to identify corrective action as a part of the management control function. Budgets and schedules are known; however, actual Btu's saved per dollar expended are not. (See figure 1 for a graphic explanation)
 2. Lacks integrated logistics support plan.
 3. Lacks PERT charts.
 4. In general, advanced-technology facilities are not planned as a system and do not provide for "cradle to grave" accountability.
 5. Lacks meaningful or complete participation in all phases of planning, including failure to define or validate requirements.

DEPARTMENT OF THE NAVY
RESIDENT OFFICER IN CHARGE OF CONSTRUCTION
SAN DIEGO AREA
NAVAL FACILITIES ENGINEERING COMMAND CONTRACTS, WESTERN
SAN DIEGO, CALIFORNIA 92132

IN REPLY REFER TO

ENERGY MONITORING AND CONTROL SYSTEMS
A REPORT
ON LESSONS LEARNED FROM CURRENT PROJECTS
IN SAN DIEGO

Prepared by:
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8 February 1980

ENERGY MONITORING AND CONTROL SYSTEMS (EMCS)
A REPORT ON LESSONS LEARNED FROM CURRENT PROJECTS
IN SAN DIEGO

INTRODUCTION

This report is the result of a review of four (4) current projects involving EMCS in San Diego and discussion with as many of the participants as were available. Problem areas have been identified and recommendations have been made as appropriate. Virtually all the problems encountered were caused by the relative inexperience of all project participants in the sophisticated aspects of EMCS. As project experience is gained and familiarity with EMCS is attained, many of the problems will become more understandable and thus more easily correctable. The specific recommendations are primarily oriented toward improving future EMCS construction in the San Diego area, but are also applicable to future projects by the Navy at other locales.

The four (4) projects examined and from which were extracted the contents of this report are as follows:

<u>Contract Number</u>	<u>Title</u>	<u>Customer</u>
N62474-75-C-6377	ELECTRIC POWER MANAGEMENT SYSTEM	NAS North Island
N62474-75-C-6547	ENERGY MONITORING AND CONTROL SYSTEM (P-215)	NAS Miramar
N62474-77-C-2703	ENERGY MONITORING AND CONTROL SYSTEM (P-066)	PEC San Diego
N62474-77-C-6193	AUTOMATED MONITORING AND CONTROL SYSTEM FOR BUILDING 600	NOSC Pt Loma

The discussion which follows is not oriented to unique problems or situations, but represent typical problems for all projects examined. Specific project reference is omitted. Notes taken during the examination process and during specific meetings and discussions regarding the projects above are included in the Appendix.

PRE-DESIGN

Design Criteria

Problem: The needs of the end user of an EMSC are not clearly defined in specific terms. Existing equipment to be monitored and controlled is not always in a good state of repair and little documentation was available.

Discussion: The user is aware that the purpose of an EMCS is to monitor and control various equipment including fans, compressors, heaters, boilers, air compressors, cooling towers, etc. and hereby conserve energy, but the exact means of accomplishing this reduction in energy consumption is not completely understood. Information on the equipment to be controlled is often lacking. Through a period of time, pertinent information such as operating manuals, installation drawings, records of modifications and repairs and other data necessary for connecting equipment to the EMCS is either hard to find or is non-existent. At times, even an understanding of an item of equipment and its interface with a total system (e.g., heating chilled water, condenser water, compressed air, steam, power, etc.) is lacking.

Guide Specifications

Problem: The NAVFAC guide specification for EMCS does not sufficiently address how the sensing equipment is to be installed and what specific monitoring and control functions should be applied for each type of equipment.

Discussion: The NAVFAC guide specification includes six (6) type specifications under Division 13 all under the general heading of Energy Monitoring & Control Systems and are listed as follows:

<u>Specification Number</u>	<u>Sub-Heading</u>
13941	General Requirements
13942	Field Materials
13943	System Equipment
13944	Software
13945	Signal Transmission
13946	Maintenance

These specifications are not only used by the Navy, but are also used by several governmental agencies including the Corps of Engineers, and are referred to as the "Inter-Agency Guide Specifications" on EMCS. Although these specifications provide detailed information on the software and central control equipment to be provided, required submittals, maintenance and the tolerances of field sensors, little information is provided on the location of sensors or how each type of equipment should be monitored and controlled. An EMCS is only as good as the information it receives and the location of a sensor can greatly impact the accuracy of the measurement taken. Additionally, information should be provided in the guide specification relating to what monitoring and controlling should be provided on each type of equipment. For instance, an air cooled refrigerant condensing unit as part of an air conditioning system (or compressor after cooler) has several items of internal equipment which can each be controlled or controlled as a group. A simple start/stop control function could be provided by the EMCS as could individual control of the condenser fans and refrigerant compressors depending on the degree of control desired. Also, how the EMCS provides a start/stop signal can interfere with the internal safety controls of the condensing unit designed to prevent serious damage

to the equipment. Inappropriate interface between an EMCS and a major equipment item such as a steam boiler, when specific safety controls of the boiler are negated, could lead to potential disastrous consequences. Clear guidance from the specification in this area is noticeably and undeservedly lacking.

A-E QUALIFICATION

Problem: The experience of engineers on EMCS projects was not always the determining factor in selection resulting in firms which were less than the best qualified being awarded the design contract.

Discussion: Selection procedures in effect for procuring design services from an engineering firm are based on a variety of factors. Experience and expertise in accomplishing similar projects is not the only factor considered in the selection process. Firms which have had more than a "fair" share of previous work with the Navy or firms with appreciable current government contracts are normally eliminated at the outset regardless of their expertise. In fact, it is these very engineering firms, which have the government experience, that can take a difficult assignment and provide a quality design. The learning curve they have had to overcome in previous government work is now a very valuable asset. The prevailing attitude in the selection process is to provide all possible engineering firms a chance to show what they can do, and not to appear to favor any one firm. The design of an EMCS involves a combining of the knowledge of building mechanical and electrical systems and an expertise in computer hardware and software; an attribute not possessed by an abundance of engineering firms. Particularly when the Navy is experimenting with a new system that very few exhibit expertise, it is not in the best interest of the government to rely on normal selection procedures.

DESIGN

Equipment to be Controlled

Problem: There is a distinct lack of information in identifying specifics on equipment to be included in the EMCS with sufficient detail to allow not only a realistic appraisal by bidders, but also to allow installation and interface with the EMCS during the construction phase.

Discussion: When the engineering firm performing design services is dealing with a less than familiar type of project, the tendency exists to gloss over some details with the hope that the contractor will be able to figure out what is to be accomplished during the construction phase. When the Navy is not sure what it wants in an EMCS, and the time allotted for design options, the engineering firm must spend a great deal of this limited time in conceptualizing the job, thus reducing the amount of detail required. The engineering firm must provide this required data based on thorough research in the field, to eliminate questions regarding where new equipment is to be located, the power available, where sensors are to be in-

stalled, temperature, humidity, vibration and voltage variations to be expected from all equipment.

EMCS Input/Output

Problem: The current format for identifying input and output points to the EMCS is not satisfactory to provide a completely understandable tasking to the contractor.

Discussion: The input/output summaries currently in use do not adequately identify what inputs and outputs are required from the EMCS. In some instances, this has lead to confusion on the part of the contractor as to exactly what the EMCS is to monitor and control. Specifically, the engineer should identify exactly what every input point for both analog and digital inputs is to be. Additionally, each output point must be identified including where it is to be located, the equipment served and how it is to be interfaced with the existing equipment operating controls. With these specifics given, then information can be supplied on what the EMCS is to do with the input data it receives and how it responds with output, whether the input is to be used in the load shedding program, or other operating routines. This explanation of the logic should include initial set points, time delays and generally which equipment is to be affected by what routines.

Training

Problem: Although the type and content of training is spelled out in great detail in the guide specification, no information is given on where the training is to be conducted or how many user personnel will be in attendance.

Discussion: Confusion has developed on differences in interpretation on the location of training and numbers to attend. In providing a bid to the design, the contractor must assume the cheapest possible alternative when no direction is given. Training should be conducted on site using the operating EMCS. However, problems can develop through governmental personnel training on the EMCS particularly if the system is undergoing the acceptance test. Generally, a minimum of three people should attend all training. This number allows for transfer of personnel and other attrition and the capability of in-house training of new operators.

Graphic Aids

Problem: The graphic displays and report formats identified in the guide specification are too extravagant and are one of the major causes in increased software costs.

Discussion: The graphic displays and automated reports called for in the guide specification do not lend toward a better control of the system. It only allows an operator to better understand what is going on in the system. Although the graphics assist a programmer in changing some command functions or reprogramming, they are not necessary. The software required to produce these graphics and reports are a major cost of the EMCS as is the hardware to perform it. A single typewriter terminal would be adequate to mon-

itor an EMCS and replace the very expensive view screen (CRT), printer and other accessories. Unless these graphics are deemed to be worth the cost, they should still be included in the specification, but as an alternate so that the Navy can easily evaluate the cost/benefit of their inclusion in a project.

Test Procedures

Problem: Although test procedures for the EMCS are generally outlined in the guide specification, they do not provide a detailed description of the testing expected to be performed.

Discussion: Testing at various phases of the of the installation of an EMCS must be accomplished to verify that the system is in compliance with the drawings and specifications. The testing should insure that all possible situations of control are exercised and that operating programs are proven valid and that reliable input data is received and interpreted. However, a complete testing of the system software is unnecessary. A capability for reprogramming the system should be demonstrated, but a complete test of the software would be similar to validating the spelling of every word in an unabridged dictionary.

Submittals

Problem: The guide specification lists a great variety and number of required submittals for an EMCS. The ROICC has experienced great difficulty on non-CQC jobs in identifying outstanding submittals.

Discussion: The number and types of submittals required are contained in the specification in the general text of the document. Without more explicit direction, both the contractor and the ROICC are forced to thoroughly review the specification line by line to determine when and what submittals are required. The engineer, as the author or modifier of the specification, is the best equipped to identify submittals required. An appendix to the specifications containing a listing of all required submittals, due dates and referenced specification paragraphs would greatly simplify the communication between all project participants as to what submittals are required. Although this procedure might allow the contractor to not review the specification as thoroughly as desired, it would at least force the engineer to read his own specification with at least a minimum level of scrutiny.

Government Furnished Equipment

Problem: Equipment and work provided by those other than the contractor has created delays and increased costs when information on what is to be provided by others is not made clear to the contractor.

Discussion: When the contractor must rely upon interfacing new equipment not furnished by the contractor or when utility or telephone service must be provided, increased costs can be experienced when these equipment or services are not provided as specified.

Submittals

Problem: Contractors have not been providing submittals in a timely manner or with sufficient information to be in full compliance with the specifications.

Discussion: Much of the problem with submittals can be attributed to the lack of familiarity of most contractors with Navy requirements. Generally, information on "off the shelf" hardware has been adequate; it is primarily that information on how the contractor proposes to build an EMCS that is lacking. There are two reasons for this. First, the contractor is still developing his own concept of what is to be done. In other words, the contractor is performing the research and development required for any new product. Secondly, the contractor considers this research and development as proprietary information which will aid him in future work, so it is often found that the contractor is less than eager to provide this newly developed proprietary information. Fears arise as to the potential of competitors obtaining this detailed information. Unfortunately, when the Navy does not receive this information, it cannot attempt to understand the EMCS and perform required maintenance programming leading to an expensive sole source maintenance contract with the manufacturer.

RECOMMENDATIONS

1. Prior to the construction design phase of an EMCS project, select an A-E to conduct a detailed conceptual design of the EMCS identifying all alternatives and options and the specific equipment to be monitored and controlled. Publish the criteria allowing review by all parties concerned and incorporate the criteria and comments into the final design tasking.
2. Modify the NAVFAC guide specification to include more detailed information on the following:
 - a. Location of sensors
 - b. Installation of sensors
 - c. Location of training
 - d. Interface with existing equipment operating controls
 - e. Guidance regarding implementation of a central logic system versus decentralized micro-processors
3. For future EMCS projects select the best qualified A-E, regardless of quantity of present or past government projects.
4. In the job specification, identify the tolerances expected from each piece of equipment in the following areas:

PRE-BID PHASE

Verification of Design

Problem: When considerable lengths of time elapse between the completion of the construction drawings and the initiation of the bidding phase, added costs have been incurred as a result of modifications to existing facilities over a period of time.

Discussion: When an EMCS is retrofitted on existing facilities over a wide-spread area, changes are to be expected to occur due to continuing maintenance and repair on a base. Also, other new construction frequently requires modifications to other facilities or site utilities. It can never be assumed that changes have not taken place even if only a few months pass between design completion and construction bidding. The A-E is the best qualified to review his own design, and he should be enlisted to review any changes at the base which might affect the validity of the design.

Contractor Qualification

Problem: Less than qualified contractors have been awarded construction contracts for the installation of an EMCS.

Discussion: For the very reason that EMCS is a relatively new concept, there are not a significant number of contractors who are well experienced in EMCS and are well represented locally, are the HVAC control manufacturers; all large firms with the required knowledge of both HVAC equipment and computer control. Unfortunately, for the most part, these firms have been unable to bid on Navy EMCS work due to the small business set aside program. When all project participants are unfamiliar with EMCS, including the contractors, construction delays are inevitable. Delays are particularly acute on those projects where contractors are trying to "break into" the EMCS market with their Navy project; trying to accomplish all of their development work during construction rather than before. Another problem is the lack of qualified contractor's representatives to provide local service. This problem will become particularly acute after project completion when the Navy will be forced into an expensive maintenance service contract.

CONSTRUCTION

Qualified Inspectors

Problem: Although experienced in general construction practices, ROICC construction inspectors are unfamiliar with EMCS.

Discussion: Adequate review of the installed EMCS is a prerequisite for a quality job. At a minimum, lack of expertise by ROICC personnel leads to an inaccurate estimate of percentage completion which leads to unrealistic progress payments. The worst case would be the acceptance of an unsatisfactory system.

- a. Temperature
 - b. Humidity
 - c. Pressure
 - d. Vibration
 - e. Voltage
 - f. Ventilation
5. On the drawings, identify the location of each sensor.
 6. In the specification or on the drawings, list each analog and digital input and output, identify where and how output points interface with existing equipment and their operating and safety controls, and describe the operating routines and which equipment are to be controlled.
 7. Indicate the location of all training and a target number of personnel to be in attendance for each course.
 8. Provide for a minimum of graphics and computer generated reports. Include the printer and CRT terminal as alternate bid items only.
 9. Define the specific tests of the EMCS in terms of a realistic operational scenario involving all equipment to be controlled and all sensors.
 10. Closely coordinate with the utility and telephone company all work requiring their services.
 11. Call in the A-E to completely verify the construction drawings and specifications if more than a few months elapse after design completion, but before the bidding period.
 12. Provide a selection process for contractors similar to that for A-E. Review qualifications closely and select five to ten qualified contractors which will be allowed to bid a particular EMCS project.
 13. In lieu of providing special training for ROICC inspectors, retain the A-E or another qualified consultant to perform field inspection of the EMCS.
 14. Provide a conference approximately one month after the pre-construction conference with the A-E, contractor, ROICC and inspectors to discuss the contractor's plan for implementing the EMCS and finalize the understanding regarding submittal content.
 15. Provide a matrix in the specification outlining all required submittals and due dates.
 16. Withhold not less than 10 per cent of the contract price as identifiable to the EMCS software.

An Overview of the Environmental

Monitoring System at Bldg 600

- 1) Monitor the environment to detect the occurrence of off normal events (as identified by sensors connected to Sensor Storage and Transmit Interfaces (SSTI). In turn, the SSTI are continuously scanned by the Central Control and Logic Unit (CCLU)).
- 2) Evaluate the impact of off-normal events, using Operator selected criteria;
- 3) Report the occurrence of off-normal events, including directing any secondary or tertiary output to appropriate auxiliary I/O devices;
- 4) Take pre-defined actions upon the occurrence of certain classes of off-normal events (Alarm Scan-initiated actions), and report such actions;
- 5) Permit an Operator with appropriate access privileges to override the effects of program-initiated actions, or to independently initiate actions;
- 6) Permit User-written Application Programs to access specific Sensor and Control points for the purpose of acquiring additional operating information or to achieve additional levels of control.

Effective System operation requires that sensors be monitored continuously and that off-normal conditions be reported rapidly through a high level processor to an Operator. In addition, to facilitate analysis of off-normal events (or the analysis of routine data), all sensor points must be assignable to periodic (trend) data gathering routines.

Three primary areas of concern exist in the NOSC monitoring environment:

- 1) the immediate detection of potentially catastrophic leaks in the chilled water supply system;
- 2) the immediate detection of radiation levels which exceed established standards (as well as monitoring short to mid-term levels of exposure);
- 3) the immediate reporting of Fire conditions, as detected via interfaces to Fire Alarm annunciator panels.

Secondary monitoring considerations include basic environmental space conditions (e.g., Room Temperatures; Duct Temperatures; Relative Humidity, etc.).

In response to these classes of events, the System must take pre-defined control actions; some of which may be subject to overriding directives from an Operator. Furthermore, privileged Operators must be permitted to initiate System control actions independent from the detection of off-normal conditions through the Alarm Scan.

During all operations, hardware and software diagnostic capabilities must insure that internal System malfunctions are accurately reported and that corrective steps are taken. All System actions and environmental status changes must be logged on hard-copy devices (with the option of creating on-line disk storage files). Details concerning the SYSTEM 206 capabilities which address these functional requirements are provided in the following sections. Figure 1 provides an overview of SYSTEM 206 Communication line assignments.

AUDIO/VISUAL ALARM PANELS

All point alarms (i.e., alarms which originate from a field sensor device) automatically cause an Audio/Visual Alarm Panel to be turned on (every SSTI has an A/V Panel associated with it; the A/V Panel is controlled using a Binary output point in the SSTI). When the A/V Panel is turned on, the Audible Alarm sounds immediately and the light turns on. After a delay of approximately 2 seconds, the light begins to rotate. The audio and visual indications remain active until either an Operator acknowledges the Alarm from the Operator Console, a local reset switch (located on the A/V Panel) is depressed, or the Alarm condition returns to normal. All alarms cause the A/V panel to turn off if several alarms are pending, each one must be acknowledged before the A/V Panel will be turned off.

AUXILIARY ALARM MESSAGES

All points in the LX20 Data Base may have an associated primary, secondary, and tertiary message. In addition, each message may have an Operator-selected route code and priority. When a point enters an alarm state, LX20 displays the appropriate message on the appropriate auxiliary device, using the parameters previously entered in the Data Base.

CORRELATED ALARM REPORTS

To assist in accurately assessing the impact of a particular alarm, LX20 also permits defining correlated Alarm sequences. If any sensor in a correlated sequence enters an alarm condition, the remaining sensors in the sequence are interrogated and their values also logged. (Note that the Leak Detection System is a special case of correlated alarm processing.)

RADIATION HAZARD DETECTION

The NOSC SYSTEM 206 utilizes a specially designed microwave radiation level sensor to determine if Building 600 is subjected to abnormally high radiation. Absolute limits for the sensor are Operator-selectable; if the limit is exceeded, an Alarm indication is immediately reported by LX20. In addition, SYSTEM 206 Trend Log capabilities permit monitoring longer-term radiation levels at periodic intervals.

LEAK DETECTION SYSTEM

The LX20 Leak Detection System utilizes a grid of strands of water-sensitive tape connected to Commugard Analog Double cards. When moisture is detected, LX20 automatically causes chilled water supply and return flows to be read. If supply and return flows differ more than a User-selected value, one of three classes of leaks (minor, major, catastrophic) is reported, depending upon the location of the detected moisture.

No action (other than reporting) occurs after a minor leak is detected. Major leaks result in the termination of chilled water flow after a User-specified delay; after an additional User-specified delay, shutdown of the 400HZ generators occurs. (An Operator can override the automatic shutdown of the 400HZ generators via an LX20 Command.) Catastrophic leaks result in the immediate termination of chilled water flow, and a subsequent shutdown of the 400HZ generators as described for major leaks.

COMMUNICATION LINE OVERVIEW

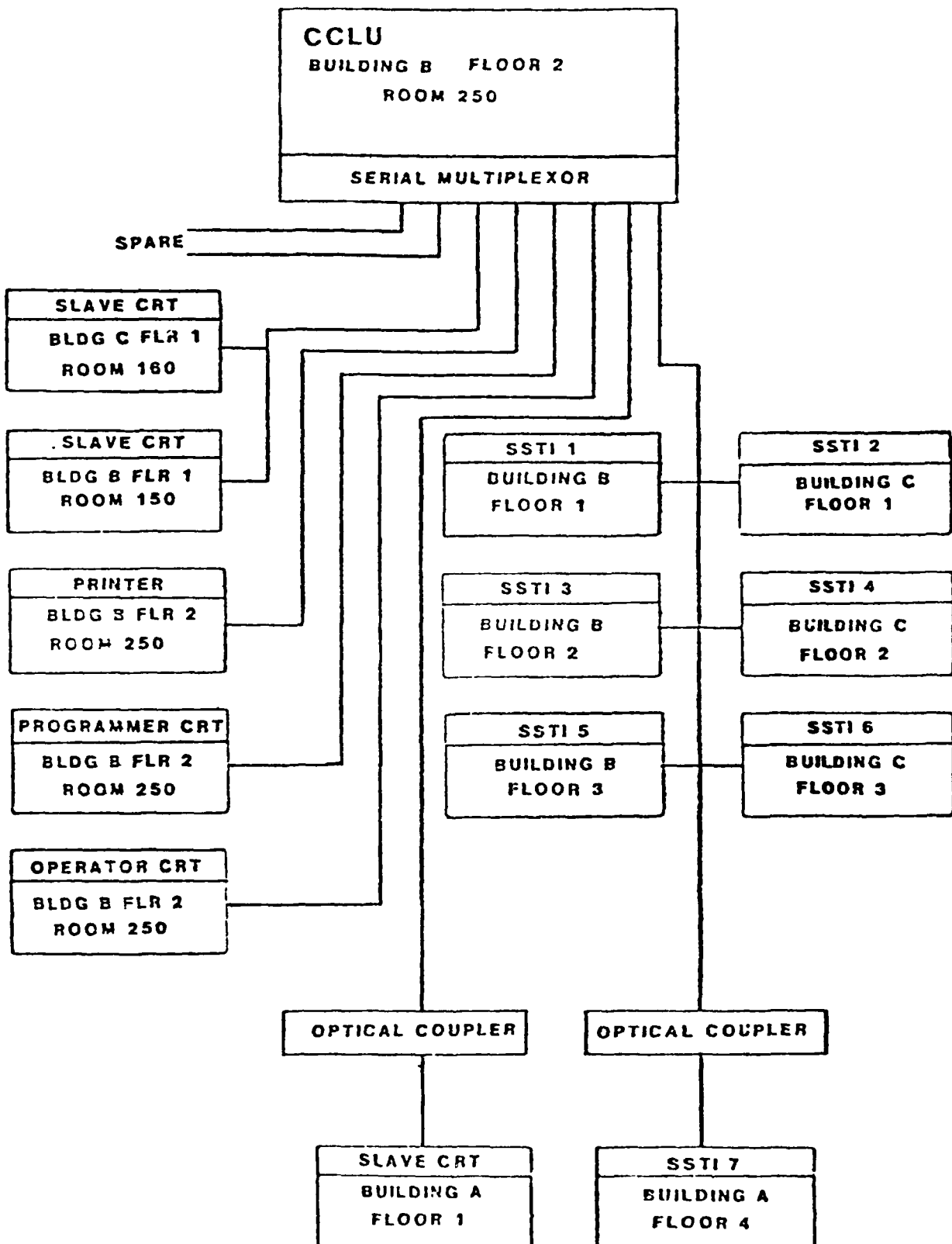


FIGURE 1

ELECTRONIC MONITORING AND CONTROL SYSTEM (EMCS) HISTORY

CAMP PENDLETON

The Camp Pendleton EMCS was born out of a manpower reduction requirement in the Maintenance Department during the early 1970's. At that time, the Maintenance Department purchased the EMCS, DELTA 2000 equipment only, with year-end funds of approximately \$84,000. Follow ons to the basic contract were negotiated in the amount of \$415,571. Currently the system has an approximate value of \$4,000,000 including installation costs. The EMCS initially provided routine watchstanding functions of the Base's boilers. This enabled the Maintenance Department to reduce its staff by 29 employees.

Although the EMCS was purchased initially to save manpower, it soon became obvious that energy conservation was another of the system's key benefits. With over 500 boilers distributed throughout 196 square miles of real estate, it had been physically impossible to readily shut down equipment when operation was not really essential. Boilers and heating systems often operated around the clock, even though they were not required to do so. The EMCS, with features of automatic start/stop functions, was applied to operate equipment only when the buildings were occupied and heating was required, and the energy savings were immediate. The initial system installation was completed in late 1973, with an original installation cost of \$495,571. This amount was paid back in manpower costs alone the first year of operation. An additional savings of \$624,196 in energy costs was also realized the first year. As a result of the foregoing savings, the General Accounting Office performed an audit on the first 83 buildings connected to the EMCS, and more than substantiated the savings.

Attachment ⑥

The existing Camp Pendleton EMCS is operational basewide and consists of the following major components:

- One DELTA 5100 Man-Machine Interface (MMI) to provide operator access to the entire system of the 411 buildings currently connected. Peripherals include one black and white CRT with keyboard, one alarm printer, one logging printer with keyboard, and one custom graphic color CRT.
- One Honeywell DELTA 2000 central processing unit (CPU) with associated peripheral equipment.
- Six W1000A CPU's distributed in the major population centers of the Base.
- One W969A Interface mounted on the DELTA 2000. This interface allows the older system to be controlled through the new system hardware and software.
- Five W1003 Annunciator modules and five W1002 printers which are utilized as a fire alarm central station allowing fire alarms in the major buildings to be picked up by the same local system and local wiring.
- Data Gathering Panels (DGP's) located in the remote buildings connecting the W1000A's and DELTA 2000 to the various sensors and control devices. Data Gathering Panels are connected to W1000A CPU satellites in the multidrop

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- Data Gathering Panels (DGP's) located in the remote buildings connecting the W1000A's and DELTA 2000 to the various sensors and control devices. Data Gathering Panels are connected to W1000A CPU satellites in the multidrop

configuration via a twisted wire pair. Sensors and control devices are individually connected to the DGP's via single or multiconductor pairs.

Per. 2.1.2

- (6) One interface for a future remote computer.
- (7) One UPS (uninterruptible power supply) for providing power to all MS equipment.
- c. Typical RTU equipment.—Each of the RTU's shall include the following minimum basic equipment:
 - (1) One microprocessor with a minimum of 8 kilobytes of EPROM memory and 4 kilobytes of RAM memory.
 - (2) Multiplexers, A/D and D/A converters, and input and output equipment.
 - (3) Indicating, isolation, and transient protection equipment for each input and output.
 - (4) One modem for communication with the MS.
 - (5) Front panel-mounted digital readout, lamps, and switches for limited local control and monitoring.
 - (6) One battery and charger to provide power to the RTU during short power failures.

SECTION 2.2—GENERAL SYSTEM TECHNICAL REQUIREMENTS

2.2.1 SYSTEM UPDATE TIME

- a. General.—Under "system normal heavy load," no more than 5 seconds shall lapse from the time a binary status or analog change occurs at an RTU until the change appears on the CRT screen. This condition shall apply when one or more of the status or analog changes has required an update on the CRT display. This 5-second response to variable changes to the display is further defined below. In addition, the total "action/response" time from initiation of a control action (on an external RTU device via the console CRT) to display of the resulting status change on the CRT shall not exceed 7 seconds under normal heavy-load conditions (assuming a zero response time for operation of the external device).

b. Normal heavy load.—"System normal heavy-load" conditions are defined as the occurrence throughout the system of a total of three status changes, three alarms, three limit excursions, and three analog quantity changes (analog quantities that exceed their dead bands) during a single 1-second interval. This number of similar occurrences shall repeat on a continuous basis during successive 1-second intervals for up to 10 seconds.

The "system normal heavy-load" condition, as described above, shall have 50 percent of the points undergoing change located at a single RTU and the remaining 50 percent of the points undergoing change distributed among the remaining RTU's. No communication channel shall be more than 65 percent loaded during this normal heavy-load condition. During normal heavy-load conditions, the logger shall print out all occurrences, but the printout need not be completed faster than the normal logger printing speed will allow. "RTU normal heavy-load" conditions are defined as the occurrence at one RTU of a total of two status changes, two alarms, two limit excursions, and two analog quantity changes during a single 1-second interval. This number of similar occurrences shall repeat on a continuous basis during successive 1-second intervals for up to 10 seconds.

Under abnormal conditions that exceed the above "normal heavy-load" conditions by as much as 10 times, the system may respond with a system-update rate proportionately longer. However, no data or alarms shall be lost and the system shall be designed to acknowledge all conditions.

2.2.2 NEW DISPLAY CALL-UP TIME

The system shall have the capability of bringing up a new display within 3 seconds (including all background portions and variable foreground portions of the display). This display call-up time shall hold true even if a different display is called up consecutively every 3 seconds.

Fountain Valley Protocol Description

The Master Station communicates with the RTU's by using a POLL / RESPONSE type of transmission sequence. The MS polls each RTU requesting status change information using the following format:

STX	- start of transmission	1 byte
BC	- Byte count (# of bytes to follow)	1 byte
ID	- RTU ID #	1 byte
Com	- Command (request for status changes)	1 byte
CRC	- Cyclic Redundancy Code (CRC-16)	2 bytes
ETX	- End of transmission	<u>1 byte</u>
		7 bytes total

Each RTU monitors the MS transmission. If the ID matches that of the RTU, a response is sent to the MS. A response to the request for status changes will be one of the following formats:

NO CHANGES - no point has changed state

STX	- start of transmission	1 byte
BC	- Byte count	1 byte
RES	- Response (no change)	2 bytes
CRC	- Cyclic Redundancy code	2 bytes
ETX	- End of transmission	<u>1 byte</u>
		7 bytes total

ANALOG CHANGES - Analog input points have changed state

DIGITAL CHANGES - Digital input points have changed state

STX - start of transmission 1 byte

BC - Byte count 1 byte

DP - # of Digital points to follow 1 byte

DPA - Digital point # 1 byte

DPS - status of point 1 byte

{

continued for each digital point that has changed state

AP - # of Analog points to follow 1 byte

APA - Analog point # 1 byte

APS - status of point 2 bytes

{

continued for each analog point that has changed state

CRC - Cyclic Redundancy Code 2 bytes

ETX - End of transmission 1 byte

7 bytes overhead

The total number of bytes transmitted by the RTU when changes occur are:

$$(7 \text{ bytes of overhead}) + 2 \times (\# \text{ of digital changes}) + 3 \times (\# \text{ of analog changes}) = \text{Total}$$

The chart below shows a typical byte count for a complete Poll/Response to one RTU

		ms TO RTU TO ms byte count					
# of Analog	5	29	31	33	35	37	39
Changes	4	26	28	30	32	34	36
	3	23	25	27	29	31	33
	2	20	22	24	26	28	30
	1	17	19	21	23	25	27
	0	14	16	18	20	22	24
		0	1	2	3	4	5

of Digital Changes

System response time

Using the above chart and the definition of 'Normal heavy load' 2.2.1.b the overall system exhibits the following

1 RTU with 3 digital & 3 analog changes	29 bytes
3 RTU's with 1 digital change each $3 \times (16)$	48 bytes
3 RTU's with 1 analog change each $3 \times (17)$	51 bytes
3 RTU's with no changes $3 \times (14)$	<u>42 bytes</u>
Total	170 bytes

Real time can be calculated as

$$(170 \text{ bytes}) / (120 \text{ bytes/sec}) = \underline{\underline{1.42 \text{ sec}}} \quad (1200 \text{ baud})$$

$$(170 \text{ bytes}) / (240 \text{ bytes/sec}) = .71 \text{ sec} \quad (2400 \text{ baud})$$

APPENDIX C - PAST FIELD INVESTIGATION FINDINGS:

NOTE THAT SOME OF THE COMMENTS LISTED BELOW (WRITTEN IN APRIL 1981) ARE NO LONGER VALID SINCE THEY HAVE BEEN IMPLEMENTED IN CHANGES TO GUIDE SPECIFICATIONS OR CRITERIA. THE COMMENTS ARE REPEATED AS ORIGINALLY WRITTEN TO PROVIDE BACKGROUND DATA FOR THE CURRENT INVESTIGATION.

In order to gather background data on the subject of EMCS design and construction procedures, a number of sites have been visited where EMCS are either under construction or operational. A number of EMCS suppliers have also been visited. Site visit notes from each visit are included in Appendix A. As can be seen from the notes, these visits occurred from October 1980 to February 1981. Other material obtained during these visits (handouts, brochures, etc.) which provides basic information not repeated in the site visit notes is included in Appendix B. Sales information or material that provides information already indicated in the site visit notes has not been included in this report. The data included in Appendix A and B along with the experience of Navy and Newcomb & Boyd personnel involved provides the raw material on which this report is based. Conclusions, concepts and ideas may be drawn from this information. The findings of the field investigation are summarized in the following paragraphs.

The approach used during the field investigation was to note any information which might be helpful in improving EMCS effectiveness. Some items noted are not directly applicable to the Kings Bay EMCS project, but have been recorded as potentially useful information for other NAVFAC organizations.

The field investigation findings have been broken into six categories:

1. General
2. Planning
3. Design
4. Contracting
5. Construction
6. Operations

While additional useful individual comments maybe found in the site visit notes and other appendix material, those items listed below were stated several times by different groups of people and are felt to be commonly accepted.

C.1 GENERAL COMMENTS:

C.1.1 USER INVOLVEMENT:

User involvement is very important to the success of an EMCS. The EMCS user should be involved in the entire EMCS process from the first day of planning through the beginning of operation. The user must actively participate in all decisions regarding the EMCS. The system is being provided to meet his needs. The user of the system must be convinced of the value of the EMCS and must be the driving force behind its purchase. Many systems performed poorly due to a lack of interest, involvement and/or enthusiasm on the part

of the end user. An EMCS should become an integral part of the operation of a facility. Those responsible for that operation must understand the EMCS as a tool and feel they can benefit from it in performing their job.

C.1.2 CONTINUITY:

Continuity on the part of the purchaser must be maintained throughout an EMCS project. The same organization and preferably the same individuals should be involved from the planning phase through the design, contracting and construction phases of the EMCS. When an EMCS project is passed from one group's particular area of responsibility to another group, many of the intentions and concepts for the EMCS can be lost or misinterpreted. This has been the case on many NAVFAC EMCS projects due to the basic structure of the NAVFAC construction process.

On a typical Navy project, Utilities Division personnel perform the initial planning and documentation for an EMCS project. That information is then passed to a Design Division group, who has not previously been involved, for preparation of the contract documents. The completed contract documents are forwarded to the Contracting Division to issue for bidding and contract awarding. After this, the project is turned over to a Construction Division, who has not been previously involved in any of the other steps, for supervision of construction. Once construction is completed, the system is released to a Public Works Department for operation.

In contrast with the Navy approach, most private industry systems actually begin with the end user. In the private

sector, most EMCS projects are initiated with an Operations Division or other group in charge of running a facility. That group does basic planning for the EMCS, obtains approval of funds, performs the design (or hires an outside consultant to perform the design), evaluates the bids, awards the contracts, and supervises the construction. When the system is accepted, the end user has been involved in the entire process. At each stage in the process, outside help is used, on a consultation basis, from groups with specific expertise. Procurement personnel assist in preparing the contract and legal aspects of the project. The leadership and decision making responsibility remains with the people who will eventually use the system during all phases of the project.

Difficulty results from personnel changes during the course of a project. It is desirable that the same personnel be involved from the beginning to the end of the project. NAVFAC EMCS projects have often suffered due to the long time schedules involved in military construction planning, design and construction phases. Personnel turnover causes a loss of continuity in the project and places the Navy at a disadvantage when dealing with a contractor.

C.1.3 USER ORGANIZATIONAL STRUCTURE:

It is important that the organizational structure of an end user be such that the advantages and opportunities afforded by an EMCS may be utilized. An EMCS may cross organizational boundaries which limit its effectiveness. This has been the case within Public Works operations at Navy facilities.

Most Public Works organizations include a Utilities Division and a Maintenance Division. Traditionally the Utilities Division is responsible for operating and maintaining thermal and power plants and distribution systems for utilities. Systems include steam distribution, chilled water distribution, water and sewers, street lighting, electrical distribution, and may or may not include communications systems. In general, Utilities Division responsibility stops at the "building line", and what happens within a building is not their area of responsibility.

The Public Works Maintenance Division's traditional responsibility has been to repair broken systems within buildings. This group also performs preventive maintenance tasks within the buildings. The actual operation of mechanical/electrical systems within a building (turning them on in the morning and off in the evening) is often performed by building occupants. Public Works Maintenance personnel often are only involved if there is a breakdown in the systems.

An EMCS crosses organizational lines in this situation. An EMCS can be used to control both systems within buildings and utilities in boiler/power plants. Thus an EMCS can affect Utilities Division, Maintenance Division and building occupant operations. In many cases, no one is directly responsible within the Public Works organization for the efficient operation of systems within buildings. Building occupants are interested in operating systems in a manner adequate to perform their function, but not in the efficiency of those systems. The Maintenance Division is primarily interested in solving breakdowns and problems and the Utilities Division does not carry its responsibilities

beyond the building wall. Thus, in a typical Navy Public Works operation, a basic organizational problem may create difficulty in the success of an EMCS.

The most successful EMCS operations occur where the EMCS is an integral part of the organization which it serves. One successful approach, common in private industry, is use of the EMCS by an "Operations Division". This group is strictly responsible for the efficient control and operation of systems throughout a facility. Other divisions are responsible for breakdown and preventive maintenance and repair. The Operations Division is responsible for manning and operation of the power plants, utility distribution systems, and systems within each building. Operations Division's primary interest is systems control. This is true whether the system be a power plant boiler or a simple single zone air handling unit in a building. The Operation Division normally maintains and operates all control systems including the EMCS. The engineer in charge of the EMCS is also in charge of all controls mechanics who maintain, upgrade, and operate local control systems for all equipment. Breakdown repair and common maintenance tasks such as changing belts, filters, etc., are performed by Maintenance Division.

One of the keys to successful EMCS implementations is to resolve the organizational niche in which the EMCS will fall. Responsibility for the EMCS and for the tasks that it performs must be clearly defined in the planning stages. Delaying this decision until system acceptance can result in a design or implementation of the EMCS which is unsatisfactory to its user and will result in poor system performance.

C.1.4 TRISERVICES EMCS GUIDE SPECIFICATIONS:

The Department of Defense "Triservice" Guide Specifications for EMCS have had a pronounced affect on EMCS projects during the last 3 years. It is important to examine the overall affect when evaluating the current Navy EMCS situation and future projects. The guide specifications came into existence as a result of experience on EMCS projects by all of the military services. Systems being provided at that time (1977) were unsatisfactory. A need for a guide specification to eliminate certain problems was identified. Some of the original objectives of the specifications were to 1) require the use of state-of-the-art hardware, 2) provide greater user programmability and independence from the system manufacturer, 3) provide systems which could be expanded on a nonproprietary basis, and 4) provide a more standardized approach among military installations. The success or failure in these areas can be seen under Section 3.3, Design Comments.

When the Triservice EMCS Guide Spec was initially released, no systems were available which could meet all specified requirements. All suppliers had to develop systems to meet the guide specification requirements. Development difficulties has caused extended delays in many Triservice Spec EMCS projects. Estimates of development times have been wrong by at least 200%.

Another factor contributing to project delays has been the multiple revisions of the guide specifications. The specifications requirements presented a "moving target" to suppliers who were developing software and hardware. As each modification of the specification was released, much

hardware and software development had to be discarded. Thus far, not a single EMCS project is fully operational which meets the current version of the guide specification. Some systems have been accepted which were built in accordance with earlier versions of the specification, but which do not meet the current requirements.

The development of EMCS guide specifications has suffered severely from a lack of investment in research and monitored test installations. Concepts having major impact on system design and cost were incorporated in the specification which were never proven in a test environment. One example is the complicated Central Control Unit (CCU)/Central Communications Controller (CCC) fail-over scheme included in the guide specifications. No analyses or tests have been performed to prove that the specified requirement provides significant additional reliability or operability. Much of the guide specification was produced based on volunteer effort or as a secondary activity. The investment in time and funds on the part of the Department of Defense for development of the primary document used to purchase between \$50,000,000 and \$100,000,000 of EMCS is small and totally out of proportion. This is particularly true since that document was essentially a developmental document. It did not describe an off-the-shelf commonly available product as is usually the case in building construction specifications. The lack of research and testing has resulted in current contracts which include requirements that have since been removed from the guide specification. Those same contracts do not include requirements now known to be extremely important as a result of experience on other projects.

Many of the original concepts and goals of the Triservice specification have now been incorporated in standard off-the-shelf commercial EMCS. This change has resulted from pressure on system manufacturers, by their own personnel and the purchasers of their systems, to provide greater flexibility, more user programmability, and more state-of-the-art hardware. Unfortunately, many of those systems can not exactly meet the Triservice guide specification. An updated version of the guide specification now being prepared may provide a version that could be used to purchase these standard systems.

While the guide specifications need additional work in the area of clarifying certain requirements, all manufacturers contacted urged the use of caution in introducing major changes to the guide specification. Systems are just beginning to move out of the development phase and into production mode. Major changes in the guide spec at this time could put the suppliers back in development mode with the accompanying delays and problems.

Even though the Triservice guide specifications for EMCS have caused many problems, the alternative of not having those guide specifications would be a much worse situation. Projects that were procured prior to the Triservice Guide Specification, in general, have had as many problems, if not more, than Triservice spec projects. Some of the worst experiences with EMCS have been a result of the use of non-Triservice specifications. The objectives of the Triservice specifications were valid, however, the execution of those concepts has not received adequate support.

C.1.5 NON-PROPRIETARY EXPANDABILITY:

One of the original objectives of the DOD Triservice Specifications was to provide non-proprietary expandability of EMCS. Very rarely could all functions or facilities be included during the initial construction increment of the EMCS. EMCS construction is thus normally phased implementation. Even if the EMCS was not phased, new building construction on a base which has an existing EMCS again raises the problem of expanding the EMCS into that new structure. Obviously the most desirable method of doing this is to write a non-proprietary specification for the system modifications which can be bid on an open basis. This was an objective of the Triservice specification. From a practical standpoint, this objective has never been met and there is no expectation it will be met in the near future. Non-proprietary expandability implies standardization of hardware and software interfaces for all manufacturers. This has not occurred and there is very little chance of it occurring.

It is theoretically possible to expand an EMCS with other than the original manufacturer if the complete documentation on the EMCS is provided. With this documentation, a second supplier could study the initial system, understand its operation, connections, and protocols and design an interface such that his products could be connected to the existing system. While this is theoretically possible, from a practical standpoint, it is not economically feasible. The cost involved in studying an existing system and developing an interface for that system can only be borne on very large projects. In situations where a few buildings at a time should be added to an EMCS, no practical way exists to

accomplish that without purchasing at least critical equipment from the original EMCS supplier.

The system expansion situation is less of a problem today than it has been in the past due to changes in the nature of the systems available. Early systems required factory performed, assembly language level, programming in order to add a single point to the system. Current systems allow the operator, with a few simple keystrokes, to define and make a new point operational.

The portion of a system expansion that must be purchased from the original supplier includes the field interface panel and its associated integrated circuit cards. All field wiring, controls, sensors, and their installation can be bid on a competitive basis. Definition of the points and entry into the central computer can be done by the Owner operating personnel. The actual installation of the field panel could be performed by Owner personnel also. The only truly proprietary element involved in the expansion is the purchase of the field interface panel from the EMCS supplier.

One approach being used for system expansion in private sector installations, is the use of a requirement that detailed unit cost quotations be provided along with each bid on the initial EMCS installation. Those unit prices are used, with the bid for the first construction increment, to calculate a total system cost based on the total expected number of field panels and points of each type. The contract is awarded to the supplier with the lowest total system cost and not necessarily the lowest first increment cost. In future expansions, the quoted unit prices are then

used, along with cost of living inflation figures, to negotiate a purchase price for additional hardware.

A similar approach could be used on a supply contract basis for Navy installations. Unfortunately, most current Navy EMCS contracts have not made provision for such an approach to future expansion. The mistaken belief that the Triservices Guide Specification would lead to non-proprietary expansion has resulted in inadequate planning for future expansion methods. Navy installations must now face the fact that, at least as far as the field interface panels are concerned, expansion must be done through negotiation with the original supplier. Alternatives to this approach are to allow a parallel system as part of a major expansion or to allow replacement the central equipment and field interface panels of the original increment.

C.2 PLANNING COMMENTS:

C.2.1 EMCS SCOPE:

The eventual EMCS scope must be defined during the planning stage. Design documents must specify the total system capacity (number of buildings, number of each type point, etc.) to allow for future EMCS expansion projects.

C.2.2 MAINTENANCE STRATEGY:

The strategy for performing EMCS maintenance should be decided during the planning stage. The design, implementation and staffing will be affected by this decision, and all parties involved throughout the EMCS procurement process must be aware of the approach to be used.

C.2.3 EXPANSION STRATEGY:

The strategy for performing any system expansion, both on a single building and major increment basis, should be determined during the planning stage. Design and contracting documents can then be prepared to implement that strategy. The least acceptable approach is to not address expansion plans. This will place the Owner in the most vulnerable position when expansion negotiation takes place with the EMCS supplier.

C.3 DESIGN COMMENTS:

C.3.1 EXISTING FIELD CONDITIONS DOCUMENTATION:

EMCS bidding and construction difficulties can be reduced by proper document of existing conditions in the design documents. Equipment to be monitored or controlled by the EMCS should be thoroughly inspected and the existing control and wiring diagrams updated to match exact existing conditions. If there are no existing control drawings, then ones should be prepared from the field inspection. Using this detailed existing field documentation, the design of the EMCS sensors and control interfaces can then be provided in detail in the contract documents. Any existing controls that are inoperative should be repaired prior to issuing the EMCS contract or should be made a part of the EMCS contract and be clearly defined as such. According to EMCS suppliers and Owner construction supervisors, this approach to the field equipment design would reduce the overall system cost and construction time. The cost and time required for the design phase would be substantially increased, however, this

should be offset by the savings in construction delays and change orders resulting from ill-defined existing conditions.

C.3.2 FIELD PANEL ENVIRONMENTS:

Field interface devices and multiplexer panels are actual small computer systems. As such, their reliability and life-time is improved when they are installed in better environments. Ideally, these devices should be installed in conditioned spaces and not in mechanical equipment rooms. Where this is not possible, the equipment can operate in more difficult environments, however, the long term effects of such environments will be detrimental.

C.3.3 I/O SUMMARIES:

Input/output summaries prepared as part of the design documents should indicate every monitoring and control point in the system. Points or groups of points should not be called for in specification paragraphs which are not shown on the I/O summary. The I/O summary should govern which points are provided in the system.

C.3.4 POINT SELECTION:

Moderation should be used in selection of monitoring and control points for the EMCS. The inclusion of unnecessary points causes an undue burden on basic system operation. Consideration should also be given to the number of points a single operator can effectively manage. On very large systems with many thousands of points, a single operator cannot effectively use the system. Multiple consoles for

multiple operators should be provided for efficient system operation. Experience at one site indicated approximately 2,000 points is the maximum for effective control by one operator station.

C.3.5 POINT/FUNCTION COORDINATION:

Effective EMCS operation requires close coordination between the hardware field points specified and the functions to be performed on those points. Design documents should specifically define which control functions are to be performed on each monitored system and which points on that system are to be used to perform each function.

C.3.6 REPRESENTATIVE SYSTEMS:

If an EMCS is to be constructed in multiple increments, the initial increment should include at least one of each system type and function ever planned for EMCS use. This is necessary in order to test the software specified to operate those system types or perform those functions.

C.3.7 SPECIFICATION EDITING:

The EMCS specifications should be specifically tailored for each project. Functions or capabilities not required for a particular facility should be deleted from the specifications. Unfortunately, on some Department of Defense projects, the Triservice Guide Specifications have been photocopied with no editing as project specifications. These specifications included all bracketed options and empty fill-in-the-blank fields, along with general and technical notes to the designer.

C.3.8 GUIDE SPECIFICATIONS COMMENTS:

A number of specific comments on the Tri-Service EMCS Guide Specification (November, 1979 version) were discussed during the field investigation phase of this project. These comments are being considered by the Corps of Engineers, NAVFAC, and the Air Force in preparing a revised guide specification. The following specific areas were noted:

- A. The specifications should define EMCS response time requirements.
- B. More definitive system reliability requirements should be specified.
- C. Training for EMCS operators should include energy conservation techniques and not just the operation of the EMCS.
- D. The documentation requirements in the specification should be clarified and expanded. This is particularly true in the shop drawing and construction documentation area. The quality of the documentation should also be defined.
- E. Major items of master control room equipment should be specified to be standard products of a single manufacturer. All computer memory, all disk drives, tape drives, etc., should be provided by the manufacturer of the computer CPU. This approach assures the owner of the ability to obtain a maintenance contract on the computer equipment in future years.

- F. The specification should require commonly available computer equipment to the maximum extent possible. Specialized or customized hardware should be avoided.
- G. Trivial details should be removed from the specification and performance specified instead. Too often the specification defines hardware or software details which are irrelevant if the overall system response and performance is satisfactory. Examples are the requirements for a certain number of vectored interrupts, instruction cycle time requirements, etc.
- H. The complex CCU/CCC failover requirements should be re-evaluated. With a distributive processing system, many projects do not require back-up capability at the central site. If back-up capability is required, it is questionable whether the configuration called for in the specification is of real value. A better solution in that case would probably be to specify redundant computers to provide a fully functional system on failure of one of the computers.
- I. The specifications should require that the Operating System obtained from the CPU manufacturer be used without modifications. This is necessary in order to maintain long term system integrity when the CPU manufacturer issues up-dated versions of the operating system.
- J. The command and application software sections of the specifications are insufficiently defined. Considerable research and effort should be expended on these areas to assure effective system performance.

K. Distributed processing functions performed in the field interface device should be limited to basic applications functions. Complex optimization algorithms should not be required to be performed at the field level.

L. A clearer and more comprehensive definition of the testing requirements for an EMCS should be incorporated in the guide specs. This includes factory testing, field testing, and final acceptance testing phases.

C.4 CONTRACTING COMMENTS:

C.4.1 QUALIFICATIONS:

Contracting procedures are one of the major areas of difference in private sector versus Navy purchasing of EMCS. The private sector EMCS approach is to visit working systems, review the performance of those systems with their owners, and then prepare drawings and specifications in which only preselected suppliers of EMCS are allowed to submit bids. The preselection is based on the visits to operating systems and the owner's experience with the particular suppliers in question. If other suppliers request permission to submit bids, they are required to submit their qualifications and prove that they have operating systems which can meet the specifications. If those qualifications are adequate and the owner is convinced that they can perform the project, then that new supplier is allowed to submit bids.

Two primary contracting procedures have been used on Navy EMCS procurements. These procedures are commonly referred to

as 1) invitation for bid (IFB), and 2) two step formal advertising procedures (two-step). In the IFB method, contract documents are prepared and released for bid. Any contractor can submit a bid and be awarded the contract if he can obtain a bond. In the two-step procedure, contract documents are released to bidders who, in the first step, submit technical proposals describing the systems they propose to furnish to satisfy the specifications. Those proposals are reviewed by the government and returned with comments to the suppliers. The suppliers must respond to those comments and then the government selects which technical proposals meet the technical specifications. Those suppliers are allowed to submit bids. The low bidder is then selected as the successful contractor. Neither IFB or two-step procedures include qualification clauses or any requirements for demonstrating working systems which meet the technical requirements. The IFB has absolutely no means for demonstrating or ascertaining contractor qualifications. The two-step procedure is better than one step in that respect. However, the two-step only examines what the contractor proposes in his technical proposal and not actual results from other projects or demonstration of working systems. The Submarine Base, Bangor, Washington used a two-step contracting procedure with unsatisfactory results. Both the IFB and two-step procedures offer insufficient protection from inexperienced and unknowledgeable contractors. Once the project is under contract, it is very difficult and generally unsatisfactory to all parties to remove inexperienced and unqualified contractors.

The use of contracting procedures which award projects based on low bid with no regard for qualification presents difficulties for qualified contractors. Experienced contractors

cannot compete against the ignorance of inexperienced, unqualified, contractors. Given this basic situation, a qualified contractor has two choices with regard to a NAVFAC EMCS project. One approach is to prepare a bid for the project by looking for opportunities for change orders in the contract documents and lowering the bid price by the amount expected to be gained in change orders. The other approach is simply not to bid on NAVFAC EMCS work. Several major suppliers of working commercial EMCS will not bid on NAVFAC EMCS projects due to the lack of qualification requirements. There are several other experienced suppliers who have been bidding that are now considering stopping pursuit of government work altogether. The result of this scenario could be that only less than satisfactory suppliers will bid on NAVFAC EMCS projects.

The objective of any contracting procedure should be to obtain a working system that meets the requirements and to insure competition in performing that work. The probability of obtaining working EMCS would be substantially improved if bids were only accepted from contractors who have proven they can do the work. A contractor qualification procedure would only be worthwhile if actual system tests and demonstrations are required. Experience from two-step projects has demonstrated examining a system "on paper" is not effective. Many capabilities described in technical proposals have later been found to be planned but not actually in existence.

A significant consideration when contemplating contractor qualification procedures is that the project design must be oriented toward existing available and demonstrable systems and their capabilities. If the design specifications

require performance not commonly available, then those capabilities can not be demonstrated as part of a qualification test. This does not mean that requirements calling for additional development could not be included, just that they could not be tested, and probably should be limited as much as possible. This factor has been one of the major reasons system qualification tests could not be performed on NAVFAC projects in the past. The NAVFAC Guide Specifications call for a system that had not been developed by any supplier. No supplier could have passed a system qualification test because all systems to meet the Guide Specification were still in the development stage. The specifications used for pre-qualification would have to be adapted to allow off-the-shelf systems rather than custom designed and developed EMCS.

The subject of contractor pre-qualification on NAVFAC projects has been discussed on many occasions. Each time this approach has been reviewed, it has been rejected. In general, pre-qualification has been viewed by NAVFAC contracting as limiting competition which is not in the best interest of the government.

In the building construction industry (which is basically NAVFAC's area of involvement), the concept of contracting on a low-bid basis with no qualification requirements is satisfactory. There are many reasons why that contracting procedure works in the building construction industry. Some of these reasons are that industry uses commonly available practices, everyday materials, and can be inspected on an element by element basis such that, if a wall has been built improperly, inspectors can see this and order it redone before going on to the next step in the building procedure.

This process is inadequate for EMCS or any high technology system. The primary difference is that the EMCS has no function or value until final system integration and operation. Individual elements of the system have no benefit unless all parts work together as a system. The only way to be reasonably assured that a contractor will provide an integrated working system is to see a similar system work before entering into the contract. Testing after a contract is awarded must be performed, but relying solely on that testing has been proven to be inadequate.

The use of pre-qualification contracting procedures alone won't solve the problems encountered in NAVFAC EMCS experience. Contracting procedures currently in use (IFB and two-step) have not prevented the successful completion of the EMCS projects. However, current contracting procedures also have not protected the Navy from the bad experiences encountered with EMCS projects. If current contracting procedures are used for EMCS or any high technology projects, there is no assurance that projects bid in the future won't suffer from exactly the same problems current projects are experiencing. Those contracting procedures provide no means to prevent a contractor from bidding and winning a job who has very little experience and lacks the capabilities to provide a working system. Current procedures allow bidders to use NAVFAC EMCS project to provide capital funding for system development.

Because NAVFAC's primary task is facilities construction, most NAVFAC contracting familiarity is with Defense Acquisition Regulations commonly used to perform that task. In reality, an EMCS has much more similarity to a ship's radar system than it does to "brick and mortar" construction

projects. Ships' radar systems are not procured on a low bid, with no contractor qualification, basis. Contracting procedures exist within the government to procure ships' radar systems from pre-qualified contractors. The same methods could be used for EMCS procurement. Overwhelming evidence demonstrating the need for using such pre-qualification procedures is provided by the state of the current NAVFAC EMCS projects. Use of this approach by private industry provides clear proof that the process can work and still provide plentiful competition.

C.4.2 SMALL BUSINESS SET ASIDE:

Some NAVFAC EMCS projects have been classified for "small business set aside". On these projects, the prime contractor is required to be a small business. The application of small business set aside to an EMCS project is inappropriate. Small business set aside does not enhance and encourage competition but instead limits it. There are very few suppliers of EMCS that can be classified as small business. Projects are thus being bid by small business prime contractors with the EMCS supplier as their subcontractors. This structure causes difficulties in technical implementation of the EMCS since all official contact is with the small business prime contractor and not with the technical expertise of EMCS supplier.

The use of this procurement requirement is causing alienation of the EMCS industry. They have invested substantial funds in the development of EMCS specifically to meet the Department of Defense Triservice specifications, and now they cannot directly bid on projects as a result of small business set aside. Small business set aside for

projects comparable to EMCS in terms of total cost in the building construction field is reasonable because a small business general contractor does not have to support a large development effort in the recovery of its cost. Application of small business set aside procedures to an EMCS is comparable to applying small business set aside to a ship's radar system. The requirement is inappropriate for use in high technology areas.

C.4.3 BIDDING SCHEDULES:

An 8 to 10 week bidding period is normally reasonable for a project of the scope and complexity of basewide EMCS. Some Department of Defense projects have been issued for bid with bidding times of only 4 weeks. This short time frame does not allow contractors to submit and receive replies to questions requesting clarification of the plans and specifications. A longer bidding period could reduce problems and time delays encountered later in the project due to insufficiently defined requirements.

C.4.4 CONSTRUCTION SCHEDULES:

When dealing with EMCS projects the size of base-wide NAVFAC EMCS, reasonable construction times should be in the 18 month to 2 year range. This time frame is required assuming all system development work is already completed. If system development must occur, successful EMCS operation could take much longer.

C.4.5 SOFTWARE RIGHTS:

Contracts which involve the use of software must include definition of the rights of the purchaser to that software. Restrictions on the use of the software must be included in the contract. The appropriate sections of the Defense Acquisition Regulations and corresponding forms must be included with the EMCS bidding documents in order to avoid licensing conflicts at a later date.

C.5 CONSTRUCTION COMMENTS:

C.5.1 ROICC TECHNICAL ASSISTANCE:

Construction supervision of an EMCS project requires specialized technical expertise on the part of the owner. Substantially more involvement is required than is normal for a conventional construction project of comparable magnitude. A great deal of coordination is required between building occupants and system operation and the EMCS contractor. Substantial effort is involved in gathering data for initial settings and operating parameters for the EMCS. On Navy projects, the Resident Officer In Charge of Construction (ROICC) office is generally does not have the technical expertise to handle a high technology project such as an EMCS. The ROICC office requires substantial technical assistance to provide supervision of EMCS construction. ROICC offices are normally not staffed from a manpower standpoint to handle the involvement required for an EMCS. Title II A&E services or other means of providing in-depth technical assistance is a necessity on any EMCS project.

C.5.2 TECHNICAL COMMUNICATION:

It is important to have direct contact between owner personnel and EMCS technical expertise on the part of the contractor's team. If the EMCS supplier is a subcontractor to a prime contractor, substantial difficulties can develop due to the lack of direct communication from Owner personnel to EMCS technical personnel. In general, it is desirable that the prime contractor on an EMCS project be the EMCS equipment supplier. When this is not the case, then a mechanism for easy communication between owner personnel and EMCS supplier personnel must be recognized as a necessity and developed.

C.5.3 INCONSISTENT INTERPRETATION:

On Department of Defense EMCS projects, suppliers have experienced substantial difficulty as a result of differing specification interpretations by the construction agency from project to project. The same guide specification paragraph may be interpreted entirely different by one ROICC office versus another ROICC office. This difference in interpretation can have substantial cost impact on the supplier who is attempting to utilize the same system as provided on the last Department of Defense project he performed. Since the Triservices Guide Specification is a very large and complex document, there will always be differences of opinion regarding the interpretation of the specifications. Some central authority should be provided which can provide technical interpretation in a uniform manner. If such a mechanism were available, then differences may be resolved without legal contests. Such a mechanism would be in the best interest of all parties, including the Navy and the system suppliers.

C.5.4 SUBMITTALS:

A comprehensive plan defining the content and processing of each contractor submittal should be prepared for each EMCS project. Difficulties can be encountered due to lack of definition of submittal requirements. The specifications should clearly define all submittals required, in what packages at what time, and what review cycle time will be required for those submittals. The plan should be realistic in its time requirements both on the contractor and on the Owner. It is impractical to require all possible submittals at one time. Submittals should be broken into logical, clearly defined, packages which should be carefully monitored for timely submittal and return of comments.

C.5.5 EXISTING CONTROLS REPAIR:

In the current Tri-Services Guide Specifications for EMCS, the contractor is required to inspect the condition of existing controls into which the EMCS will interface. The Owner is then required to repair or replace controls found by the contractor not to be operational. Prior to including such a requirement in the specifications, a plan of accomplishment of Owner responsibilities should be prepared. Parties responsible for accomplishing the control repairs or replacements should be fully aware and ready to accomplish the work in a timely manner. This particular area has led to extended delays on several projects. If the detailed documentation of existing conditions was accomplished as previously suggested in this report, this process would be greatly simplified or eliminated.

C.5.6 TESTING:

Testing of an EMCS is an involved time-consuming process requiring substantial manpower to be effective. On many less than satisfactory EMCS projects, problems may have been averted if more substantial effort had been expended in the area of testing on the part of the owner.

Tests called for in the specifications must be enforced. Most DOD EMCS projects call for factory testing to demonstrate complete operation of the system. On many occasions, factory tests have been approved by government inspectors, even though the system tested was far from meeting all specified requirements. In some cases this was the result of ignorance on the part of the government representative and in other cases, approval was rationalized to "expedite" the project. Experience now shows clearly that the lack of adequate factory test enforcement is not in the best interest of the government. If adequate enforcement of the factory test had occurred, many problems experienced later in the field could have been solved in the more controlled environment of the manufacturer's facilities and in a much more satisfactory manner.

Some EMCS projects have been designated to use Contractor Quality Control (CQC) procedures. This approach has proven to be very unsatisfactory. CQC procedures are oriented toward quality control of individual elements of a project. CQC is inadequate for testing and certifying of system performance as a whole. CQC procedures should not be used for EMCS or other high technology projects.

C.5.7 PROGRESS PAYMENTS:

Specialized progress payment procedures should be established for an EMCS project. Traditional military construction progress payment procedures are inappropriate and can promote difficulties encountered on some projects.

Conventional progress payment techniques are based on a "work in place" concept. This approach bases progress payments on the number of elements of a project that have been installed. With an EMCS, the value of the elements is only realized if they work together as an integrated system. If total system operation is unsatisfactory, then the individual elements have no value. This fact has not been recognized on many EMCS projects and has resulted in cases where over 90% of a contract amount has been paid in progress payments without a single minute of system operation. System integration, start-up and documentation are the most difficult and critical portions of any EMCS project. Yet the contractor has very little incentive to see those parts of the project to satisfactory completion.

Progress payments are often made by government personnel unfamiliar with the technical aspects of the system. In some cases, very little value has been placed on software by the contractor and thus, delays or incompleteness in software delivery has a very small profit and loss impact on the contractor. However, the system performance impact of such problems can be disastrous. Construction contracting methods allow a contractor to provide a price element breakdown after he is selected as low bidder. In most cases, this breakdown is heavily weighted toward elements of

work accomplished early in the contract with very little cost indicated which is based on successful system performance.

Alternate approaches must be developed for an EMCS project. One method of providing progress payments while insuring system performance would be to pre-define progress payments based on successful completion of an increment of work. An example of this method could be as follows: An EMCS total construction contract for \$1 million is let for a military base with 20 buildings. All the buildings are of equal size and have equal potential savings to the government from EMCS operation. Progress payments would be based on successful completion of installation, testing, and operation of each building connected to the system. The payments would be in proportion to the savings estimated for that building. Thus, for a facility with equal potential for each building and 20 buildings, the progress payment per building would be 1/20th of \$1 million or \$50,000 per building. Once the contractor had successfully installed his central equipment and all software and had placed the first building in complete operation in accordance with the contract documents, he would receive his first progress payment of \$50,000. Following completion of successful EMCS operation in the second building, he would receive an additional \$50,000 progress payment and so on until all buildings on the facility were successfully operating.

This approach places a substantial burden on the contractor from a financing standpoint, which would in the end, be borne by the Owner as part of the contract price. However, the resulting savings from lack of delays and higher probability of system operation could easily outweigh the

additional expense. If contractor pre-qualification methods were used, this extreme progress payment method might not be necessary. If contractor pre-qualification was not included, then this progress payment method might serve to provide a form of pre-qualification since the contractor may have to convince a lending institution that he could perform the specified project in a timely and satisfactory manner.

C.6 OPERATIONS COMMENTS:

C.6.1 STAFFING:

EMCS staffing and operation varies widely from site to site. Deciding how an EMCS is to fit into a facility's operation organizational structure is the first step in determining staffing requirements. This is discussed in Section 3.1 of this report. Once the organizational problems are resolved, the question of numbers and qualifications of personnel involved must be addressed. In all cases, EMCS effectiveness has been found to be directly proportional to the capability and interest of the people assigned to its operation. While educational background is important, interest and enthusiasm for the EMCS have been found to be more important qualifications than formal training. In general, operating personnel backgrounds should be in the systems being monitored and controlled by the EMCS and not in the elements (computers, electronics, software) of the EMCS itself. The EMCS must be a tool to accomplish a task and not an end product itself. At one site, the EMCS operator is the foreman in charge of all boiler operators. At another site, the operator is the controls mechanic's foreman. One difficulty encountered in using military personnel in EMCS operation is the relatively short turnover as they are rotated to another assignment.

While not necessarily used as system operators, engineering personnel must be closely involved in EMCS utilization in order to fine tune the efficiency of operation of the systems being controlled.

C.6.2 ON-GOING TRAINING:

A program for ongoing training of EMCS operating personnel is a necessity due to personnel turnover. One approach to this problem would be the creation of a centralized training group within NAVFAC which could provide centralized training instruction for all Navy sites.

C.6.3 MAINTENANCE:

Maintenance of an EMCS must be recognized as a substantial long-term commitment. If the system is not maintained and repaired properly, poor operation and loss of confidence can result. Maintenance can be performed by owner personnel, by the supplier on a maintenance contract basis, or some combination of each. Most successful systems have some basic maintenance capability on site full-time. If a maintenance contract is used, the contract should specify a fast maintenance response time to guarantee provision of local personnel. If a maintenance contract is used, it must be continuous in order to be effective. It is possible to convert from a full maintenance contract to maintenance by site personnel or "on-call" maintenance. However, it may be difficult to convert from owner maintenance to contractor maintenance after any substantial time period without contractor maintenance.

APPENDIX D - PAST INVESTIGATION RECOMMENDATIONS:

NOTE THAT SOME OF THE COMMENTS LISTED BELOW (WRITTEN IN APRIL 1981) ARE NO LONGER VALID SINCE THEY HAVE BEEN IMPLEMENTED IN CHANGES TO GUIDE SPECIFICATIONS OR CRITERIA. THE COMMENTS ARE REPEATED AS ORIGINALLY WRITTEN TO PROVIDE BACKGROUND DATA FOR THE CURRENT INVESTIGATION.

In order to avoid difficulties encountered at other Navy installations, certain concepts and procedures should be adopted for EMCS projects. Recommendations are included below. If these recommendations are followed, then a very high probability of successful EMCS operation is expected. If these recommendations can not be adopted, that probability would be reduced and the project should be re-evaluated on that basis.

This report provides recommendations addressing general procedures. Technical comments included elsewhere in the report should be incorporated during design and other phases. Contractural and organizational recommendations require coordination with parties involved in those areas prior to the implementation of a EMCS project.

The following items are recommended to provide reasonable assurance that an EMCS project will be successful:

D.1 ORGANIZATION:

An "Operations Division" should be established within the Public Works organization which would be responsible for the efficient operation of all utility and building systems. This division would be responsible for all control system

operation and maintenance, including an EMCS. This division would not be responsible for maintenance or repair of equipment or distribution systems. Within the Public Works organization, the Operations Division could be a part of the Maintenance Department or the Utilities Department, or it could be a separate independent department.

D.2 USER INVOLVEMENT:

A Public Works EMCS implementation team should be established at this time to advise and coordinate with the design agency in system planning and implementation. The team should include members from Public Works Engineering, Utilities, Maintenance and Energy Conservation groups. This team should meet regularly with the design agency personnel to review concepts, progress, and plans for EMCS projects. If an Operations Division within the Public Works organization is established as previously recommended, then a representative from that group should be a member of the team and act as its chairman. The objective of forming such a group is to fully prepare the Public Works group for using the EMCS as an integral tool in Base operation following completion of construction. A comprehensive EMCS maintenance and operating plan should be developed jointly by this group and the design agency prior to system design.

D.3 BIDDER PREQUALIFICATION:

The single most important element in increasing the probability of EMCS success is a requirement for contractor/system qualification. This is the primary difference between successful private industry projects and Navy projects. Potential bidders must be required to demonstrate

a working EMCS which meets the project requirements before they are allowed to bid.

The legal mechanism to accomplish this objective and still maintain competition must be investigated in detail prior to implementation of an EMCS project. The results of that investigation and recommended methods should be included in the contract documents. That effort will require considerable involvement on the part of the legal staff. Once the appropriate technique is selected, it will be submitted for approval of the required authorities. If pre-qualification, or equivalent means, is not approved, then an EMCS project may experience the same difficulties found on similar NAVFAC projects.

Implementation of other recommendations including in this report will significantly improve the chances of success, however, if no qualifications are required for system bidding, the improvement may not be sufficient to guarantee success and justify the expenditure.

D.5 DESIGN:

Technical comments described in other sections of this report should be implemented as part of the design of EMCS projects. The two most significant comments are: 1) the need for detailed existing conditions documentation and interface design, and 2) commitment to use off-the-shelf commercially available systems. When EMCS installation is to occur in an existing facility, detailed existing conditions drawings and EMCS interface design should be prepared and checked out in the field as a part of the design process. Exact sensor locations could be physically determined.

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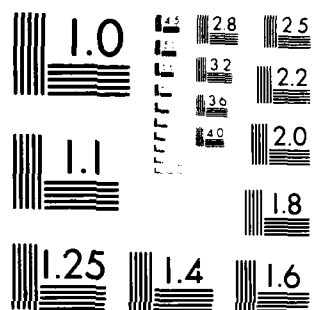
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field during the design stage. The system design should be oriented toward commercially available working systems. This approach is a necessity if prequalification of bidders is to be performed. Specialized or customized features won't be ruled out, but should be recognized as such and the cost vs value carefully evaluated.

D.6 PROGRESS PAYMENTS:

A progress payment system for EMCS projects should be implemented where payments are dependent on system performance and not on hardware delivered to the field. This approach will require careful testing and the contract documents must clearly define the performance required.

D.7 CONSTRUCTION TECHNICAL SUPPORT:

Comprehensive technical support must be provided to the ROICC Office during the construction supervision phase.

D.8 TESTING REQUIREMENTS:

Detailed testing requirements must be included in the design specifications to assure system performance and reliability. The Navy Civil Engineering Laboratory is currently performing research in this area. The tests for EMCS projects should be based on that research. Complete test procedure for prequalification of bidders must also be defined.

APPENDIX E - FOLLOW-UP INVESTIGATION SITE VISIT NOTES:

The site visit notes included in this Appendix have been reviewed by the attendees at the various meetings. The notes were distributed to meeting attendees with a request for corrections or clarifications. Comments were incorporated in the site visit notes included in this version of the report. Where site visit notes refer to attached data, see Appendix F.

NAVY CEL EMCS STUDY

SITE VISIT NOTES

TRIDENT SUBMARINE BASE
BANGOR, WASHINGTON
AUGUST 16, 1983

ATTENDEES:

Steve Bruning	Newcomb & Boyd	(404) 352-3930
Jerry Milmont	Navy CEL	(805) 982-5778
Victor Schoessler	Wood/Harbinger	(206) 476-8140

Vic Schoessler described some of the history of EMCS installation at Subbase Bangor. The original concept for central monitoring system (EMCS) was the system would eventually handle a total of 30,000 monitoring and control points. The first EMCS project was installed by Wismer and Becker as the Contractor, as a turnkey type project. That system was specified to be a 2,000 point system, with a 100% expandability. Wismer and Becker did the detailed design of the system and installation, using Esterline hardware. Apparently, there was some conflicts between Wismer and Becker and Esterline during that contract. Bovay Engineers prepared the original bidding documents by which Wismer and Becker bid that project. That contract is still in dispute, although it has been closed in order to award the project that is currently under construction.

A dedicated communication network was installed for use by the EMCS. That network was installed as part of the Wismer and Becker contract, and is being expanded and modified as part of the current contract. Many problems developed from that network, due to very poor splicing and termination procedures. Materials used were very unorthodox. Placement of the cable (depth and location) was very poor. In some cases, cables have been found only 6" below grade, even though the drawings clearly called for 30" deep burial. Most of the cable is direct buried, and is of the air core type. Some cable was installed in duct banks, but air core cable was also used. Splice cases were not filled properly, and resulted in many problems. The project was a CQC Project, but could not have been inspected properly, based on installation problems that have been found since the termination of the contract. As part of the current EMCS project, most of the splicing of the communications network was reworked or modified, and that cleared up most communications problems. They still have difficulty with cable being dug up as a result of other construction activities on the base. Some deteriorated cable sections have been found and replaced.

The communications cable installed under the first EMCS contract was required to be tested extensively as part of the current EMCS contract. As a result of that testing, additional work was added to the current contract for the rework of the splicing, and some cable replacement. All this work was done by change order. One of the change orders required a TDR test of each reworked splice and cable section. Many of the splices were reworked as part of the base contract, and thus, did not require change orders. The additional splice rework done by change order was included in PC #5, which was for approximately \$75,000 and a 55-day contract extension for the splicing modifications.

The current EMCS contract is with Oak-Adec. It was awarded September 29, 1980, and included three phases. The first phase included a base-wide water monitoring and control system which would monitor water pumping, tank levels, and recharge fields. The system included monitoring of tanks and flow rates, and start/stop control of well pumps. Once this phase of the EMCS was operational, on two separate occasions the system failed to properly control a one million gallon main storage tank, resulting in tank overflow, and damage to the surrounding areas. The targeted beneficial occupancy date was May 1981, for this phase of the contract, but after failing several tests, the system was accepted in July 23, 1981 with a punch list. Punch list items are still not completed, and today the system is not operative. One of the problems with the system is that multiplexers FIDS, terminals, etc., at the mid-way pumping station (water system control location) were removed for construction in the building in order to protect them. Oak-Adec now will not reinstall those pieces of equipment without a change order. The Navy position is the equipment would not have been required to be removed if Oak-Adec was not so far behind schedule. While the system was operative, it was used on a manual control basis. The system was tested in automatic mode for some time. The punch list items included sensor adjustments, response time problems, compensation for accuracy problems, etc. Oak-Adec currently claims the warranty on the Phase I portion of the system expired in July 1982.

Second phase of the current EMCS contract included the completion of the installation of the entire EMCS culminating in a 30-day operation acceptance test. The current estimate of completion is approximately 80% complete. Payments have been stopped to the contractor since March of 1983. The field installation is probably a higher percentage than 80%, however, software has not been delivered for the system. The contractor claims 100% of the field installation is completed, but CQC reports show substantial field work will be needed to correct outstanding items. The contractor's field CQC has been very effective and complete. In

terms of the field electronics, none of the FIDS or MUXS are completely installed. Some of the units have cards installed on a temporary basis for testing, but none are completed.

All software for the project was to be provided by Oak-Adec. The specifications clearly called for the contractor to fill out all database forms. Oak-Adec tried to get the Navy to do this, but when pointed out in the specifications. Oak-Adec agreed, and did complete the forms. All database input at this point consists only of point related data, and does not include any applications software database. Oak-Adec claims to have application software ready. A schedule for delivery of software was set up in March of 1983. A follow-up meeting in July was held to investigate why the March 1983 schedule was not adhered to. Oak-Adec has still not completed the software to the point that a factory test can be accomplished. On two separate occasions, factory tests have been executed, but both have failed to meet the requirements. In March, Oak-Adec proposed having a field demonstration, instead of a factory test of the application software. The Navy indicated they would consider this if Oak-Adec would say what is to be done in the field demonstration, and provide an exact itinerary of what was to be demonstrated. That information was never provided. In the July 1983 meeting, this was discussed, and no response has yet been received by the Navy.

There have been a number of disputes during the contract over software license agreement. Oak-Adec finally proposed a license agreement that was very unacceptable to the Navy. The Navy made a counter-proposal to Oak-Adec which was then returned to the Navy, and an impasse was reached. This was discussed in the March, 1983 meeting, and again discussed in the July 1983 meeting. Work is still continuing, but the license agreement is not resolved. Oak-Adec claims it cannot deliver the software until a license agreement is signed. In the original contract specifications, no reference to the defense acquisition regulations DAR or software license agreement was included.

One requirement of the current contract which was highly recommended is the requirement that the central equipment be of such model that at the time the government accepts the project, it is a current production model. One dispute is that the computers originally delivered by Oak-Adec are not longer manufactured. Oak-Adec claims replacement of those machines is an enhancement, while the Navy's position is that the contract requirement for a current production model covers the replacement. The specifications calls for a 15-second alarm response time. Oak-Adec indicated the response time would be approximately 1-minute. This point is still in disagreement.

The drawings and specifications clearly calls for dual central communication controllers (CCCs). Oak-Adec claims that they do not have to install CCCs, because their FIDS can talk directly to their central control units (CCUs). Oak-Adec proposes approximately an \$80,000 credit for dropping the CCCs. The Navy has sent a letter to Oak-Adec, saying they will allow them to prove the performance of the system, and if it meets the performance requirements, the credit proposal will be accepted, and if not, then, CCCs must be installed with no charge to the government. Letters on the point have been exchanged several times, and it is still not resolved. Current EMCS contract is for a system of approximately 5,000 points, with a requirement for 100% expansion capability. There is some question as to whether the system will be able to meet the performance requirements at the 5,000 point level, let alone the full 10,000 point implementation.

User involvement in the project ranges from optimistic to pessimistic. For example, the water department had no input to the design of the water control system, and the initial flooding problems indicated earlier created substantial distrust of the system. One possible way to overcome this would be to bring users to the factory test to get familiar with the system. Very few of the people who will be the eventual users of the system had any input to the original system design. In terms of the electrical distribution monitoring, a number of points were included in substations, but these were not the ones suggested by the user, and user input was ignored in some cases in the design process. The one line electrical diagram requested by the using personnel was left out of the original contract requirements. The water system users knew of changes in the system that could have saved months of difficulties with the EMCS implementation, yet, because of the lack of involvement, these were not considered in the design process. At this time, there is a tremendous problem with lack of confidence in the system on the part of users, because of the difficulties in the contract. It would be useful to have the ability for users to "play with" the system to learn its features and functions. The instruction courses should be set up for the level of user capability and interest. In terms of Command involvement, the users are under the impression that the system will never work, and until they see it work, have no confidence in the project.

Continuity on the part of both the government and the contractor has been a problem on the project. Currently, the Navy has the third AROICC, the second general engineer, and the second supervisory representative, and the second contracting officer. Each individual has had their own personality and approach to the project. Title II services with Wood/Harbinger (the design engineer) were included in the project, and Vic Schoessler has

been on the job since the contract was awarded. In addition to Navy turnover, the contractor has had similar turnover in project managers and other personnel involved in the project.

In terms of the user organizational structure, the plan for the system is to have seven remote terminals and printers in various shops, so that each of the maintenance shops can have access to the systems they are responsible for. Electrical distribution, water plant, fire department, security department, duty office, main gate, and the main master control room will all have operator's stations. The current plan is to man the main control room twenty-four hours per day, if the system is ever operational.

In terms of system expansion, the strategy that has been followed for new building construction is to install the FIDS as part of that new building's construction. The specifications for the new buildings included a proprietary specification for Oak-Adec FIDS. Some difficulties were encountered in specifying the proper model numbers. One anticipated problem is that those FIDS and their field installation have never been tested as a part of the overall system, since the overall system is not operational. Those building contracts do require that the FIDS within the building be tested, however, it is difficult to perform since the central system is not operating. Building contract includes all work associated with that building, and at the central EMCS, including entering of the database, graphics, and other central equipment work.

Phase III of the EMCS project is a training program, which will include operation of the system by the contractor for a period of time.

In terms of contract requirements related to existing field conditions, this project did have some unusual requirements since all sensors and devices installed under the Wismer and Becker contract were available to this contractor to reuse. The existing conditions in the current contract indicated that were existing EMCS sensors and communication cables only which could be reused. All electronics and computer equipment had to be replaced as part of the contract. For those elements that were to be reused, they can be made a part of the system if they can be proven to be adequate for the specification requirements, and if the contractor elects to use them, and he must assume liability for them. If he finds those existing devices inoperative, then the government has responsibility to fix those devices. Some disputes resulted from this paragraph where Oak-Adec claimed ambiguity. The paragraph was clarified, and a change order request to Oak-Adec responded with a \$90,000 proposal. The Navy

declined their proposal. At a later time, Oak-Adec requested and got the detailed Wismer and Becker submittals and proposed to use the same sensors. Now, Oak-Adec claims it does not have sufficient information. They claim they cannot take the time to study the Wismer and Becker submittals to find the data that they are requesting. That point is becoming a substantial dispute. Some of the buildings included in the project did not include any EMCS installation from the Wismer and Becker contract. In those buildings, the design drawings showed detailed wiring diagrams and where to connect in an existing circuit. Generally, showing those detailed requirements was successful with few disputes. The system of using stickers to locate sensors for the contractor by the design engineer was very effective. Some problems were encountered where the base changed controls after the design was completed or the controls were not installed as they were shown on the drawings. Those problems were generally worked out in the field without change orders.

The original bid price of the contract was \$3.98 million dollars. Up to this time, change orders have been negotiated to increase the contract to a total of \$4.3 million dollars. Approximately \$3.3 million dollars of the contract has been paid up to this point.

One suggestion was to require demonstration of all application programs, prior to award of the contract. Another suggestion was not to pay over 50% of the total project value, until it is complete and operational with all application software.

The original contract completion schedule was for 500 days. Submittals on the project were piecemeal and incomplete, and caused a great deal of difficulty.

One of the biggest problems on the contract resulted from the fact that progress payments were made, and hardware was delivered to the site before a successful factory test was ever performed. The specifications had a requirement that central equipment and field electronics could not be delivered until after the factory test. The Navy allowed that requirement to be bypassed by allowing payment for "procurement and delivery" as called for in the contractor's schedule of prices. Thus, a great deal of equipment has been delivered and progress payments made for that equipment even though factory tests have never been satisfactory completed.

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NAVAL REGIONAL MEDICAL CENTER

SITE VISIT NOTES

BREMERTON, WASHINGTON
AUGUST 16, 1983

ATTENDEES:

Steve Bruning	Newcomb & Boyd	(404) 352-3930
Jerry Milmont	Navy CEL	(805) 982-5778
Rick Eimar	Naval Regional Medical Center Bremerton, Wash.	(206) 478-9330

The Naval Regional Medical Center (NRMC) has two central monitoring and control systems. Those are a central fire and security alarm system provided by Compuguard, and a central HVAC monitoring and control system provided by Honeywell. Those systems were installed as a part of the original building construction.

The Compuguard fire and security system was reviewed. The Navy has now installed a Gamewell Flex-Alarm fire alarm system to provide for that function. The fire alarm sensors report directly to Gamewell local alarm panels. Auxiliary relays within those panel notify the Compuguard system. Originally, the Compuguard system was to provide all fire alarm functions, however, many difficulties in its operation resulted in installation of the Gamewell system. At this time, the Gamewell system performs all life safety activation functions, such as: electric door closers, alarm horns, etc. The Compuguard system still performs the HVAC fan shut-down function as a result of inputs from the Gamewell system, and displays and logs all alarm activity. If an alarm occurs, the Compuguard system can indicate the exact zone or location of the alarm, based on input from the Gamewell system. The central cabinet of the Gamewell system indicates which level of the hospital the alarm occurred on, not the exact sensor or zone.

The NRMC has encountered continuing hardware problems with the Compuguard equipment. They have been attempting to acquire funds to replace the Compuguard gear. At this time, two of the communication channels for the system are down, and hospital personnel have been trying for two months to get parts to repair them.

All of the original security functions such as motion detectors, TV theft alarms, etc., and door switches are still on the Compuguard system. The card access door control systems are a separate RUSCO system, that is independent of the Compuguard system.

Although in the early stages, a number of problems occurred with the Compuguard software operation, after receiving the latest software package update, most of those were eliminated, and the software appears to be operating properly.

The strategy used to maintain the system is for hospital personnel to swap electronic cards in and out to isolate a problem, and then return the defective card to the factory for maintenance and repair.

No attempts have been made to expand the Compuguard system. In order to make the most basic changes, Compuguard had to be retained to make those changes to the software. That has been done once, but the cost was prohibitive, and no additional changes have been made.

The Honeywell Delta 2000 monitoring and control system was discussed. The system basically only monitors and provides manual control of HVAC systems throughout the hospital. Its only automatic operation is for some simple time-clock like functions. The system has worked, generally, trouble-free since its initial installation. The hospital has considered upgrading the system from a Delta 2000 to a Delta 1000 system, but thus far has not justified the cost. Maintenance of the system is through the primary maintenance contractor for the hospital, PAN-AM Services. PAN-AM has a subcontract with Honeywell for maintenance. The system is manned twenty-four hours per day, by boiler plant operators.

Based on the experience at NRMC, the primary recommendation related to EMCS procurement is the need for contractor qualification, prior to allowing them to bid for the contracts.

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WHIDBY ISLAND NAVAL AIR STATION

SITE VISIT NOTES

WHIDBY ISLAND, WASHINGTON
August 17, 1983

ATTENDEES:

Steve Bruning	Newcomb & Boyd	404) 352-3930
Jerry Milmont	Navy CEL	505) 982-5778
Keith Kuenzi	Utilities Engr.	
	NAS - Whidby	
	Island, Wash.	(206) 257-3394

The Whidby Island EMCS is located in the Utilities Division of the Public Works Department for the Air Station. A utilities specialist operates the system during the primary eight hour shift. At night, monitoring and control of the system is shifted to the main boiler plant through an alarm printer located there. During that night operation, limited commands may be issued through a password protection scheme by the boiler plant operators. Generally, if the boiler operator receives an alarm, he calls the maintenance trouble desk to get the appropriate action.

The project history began with the Air Station submitting a project to Western Division of NAVFAC in the 1974 time frame. In approximately 1976, the project was released for two-step proposals with six or seven contractor submitting proposals. The contract was awarded to Johnson Controls in approximately 1979. Some delays in completion of the contract were experienced due to software delays and completion of the factory tests, but these were not felt to be major delays in the project. The system was completed approximately January, 1981 with the hardware warranty running until January, 1982. Software was not actually completely delivered until June of 1981, and warranty on that ran until June of 1982. Very few substantial change orders were issued during the construction contract.

The station was actually adding additional buildings to the system, even before the warranty ran out.

Maintenance of the system is currently performed through a yearly Johnson service contract that includes one man-day per month hardware checks, and two man-days per month software support. If

a field problem occurs in the system, Public Works Electronics people trouble-shoot, and Johnson will send a replacement card by mail if needed, and bill on the next month's service contract. Public Works personnel trouble-shoot central equipment and if a problem is found, Johnson picks up the central equipment item and takes it to Data General (the computer manufacturer) for repair, as a part of their contract. Most of the work in the contract is done on a time and material basis, if the problem doesn't occur during a regular monthly scheduled maintenance. During the period between expiration of the warranty and before the yearly contract was awarded, maintenance was obtained from Johnson by a monthly purchase order on a sole source basis. This proved cumbersome, and the yearly contract was awarded on a sole source basis. The yearly contract includes approximately \$19,000 for labor, and \$6,000 for material. Johnson quoted price is \$465.00 per day for software maintenance, and \$670.00 per day for hardware maintenance. This difference is primarily due to the fact that the software is maintained for Johnson by an individual who lives near the Air Station.

The Whidby Island system was installed as part of a three Base project, totaling approximately \$2 million dollars. Although no detailed breakout of the contract was ever provided, it's estimated between \$600,000 and \$800,000 of the total contract was for the Whidby Island Air Station. The Base personnel feel that the annual maintenance contract is able to be done for only \$25,000 because much of the maintenance leg work is done on a local basis. If problems have not been found during the previous month, the software maintenance days included in the maintenance contract are used to do minor enhancements to the system as identified by the Navy personnel.

The system includes a Data General S-130 Eclipse central computer with an MP-100 Micro Nova as the back-up for the CCU. The system has manual selection of the back-up or primary mode. The system originally had only one disk drive, but an additional drive was purchased in September, 1982 with year end funds. One of the drives is used by the EMCS, and the other one can be on-line. All EMCS software resides on one disk, such that a single disk failure will allow the system to operate on the other disk. Originally, the system used a 300 baud communication link to the boiler plant. That was replaced as part of another project with a 1200 baud Decwriter III alarm printer because the boiler operators performed an all points log each night. At the lower speed, that log took too much time.

Communications with the system used existing government-owned telephone lines, which did not meet Bell 3002 specifications. Nevertheless, the system has had very few problems with

communications. The few problems that have occurred, have been found due to physical problems in the field. The system uses all two wire communications links to the FIDS.

FIDS provided in the system have microprocessors, but do not have stand alone control capability.

One of the main features of the system is its ability to define calculated points. Using the calculated point features, Navy personnel has performed significant programming of the system. It was found that some of the "canned" optimized start/stop functions delivered with the system were not adequate and calculated point feature has been used in an attempt to overcome this.

Application software provided with the system included scheduled start/stop, duty cycling, optimum start/stop, interlocking, and demand limiting, in addition to the calculated point capability.

Currently, demand limiting is not being performed because the base electrical meters are not connected. Plans are underway to connect those meters and implement load shedding. At this time, load shedding is being performed by manual process.

All FIDS were provided with complete battery back-up, but the Base is not bothering to maintain the battery operation. Because power failure results in shut-down of all the controlled equipment, and since the FIDS have no stand alone capability, battery back-up is not of value.

The system includes approximately 700 total monitoring and control points, including 300 digital input, 200 digital output, 200 analog input, and approximately 12 analog output points. It monitors and controls forty-four buildings through fifty-five field interfaces devices. Roughly, forty buildings and forty-five FIDS were included in the original contract. Additional buildings have been connected as a part of construction of those new buildings. The strategy for addition to the system has been to include a proprietary spec for Johnson FIDS in the building construction contract. Those contracts do include complete software implementation and testing as a part of the building contract. Although no hard figures are available, it is estimated that Johnson is bidding approximately \$1,000 per point for new additions to the system in new buildings. Johnson has not gotten any of the local control portions of the those new building constructions where a proprietary EMCS specification has been included.

One potential upcoming problem is that, in the next year, the Air Station operations will be bid on a contract basis. If this occurs, the Utilities Division will be modified from an organization standpoint. At this point, it has not been determined where the EMCS will fit within that organization.

User involvement in the EMCS process at the Air Station has been significant and has provided very satisfactory implementation.

Training on the system included four one week sessions. After the third session (programming), the fourth session, which was additional programming, was converted to additional operator training. It was felt that the programming training was not worthwhile because it could not be sufficiently indepth to cover the subject matter and it was unlikely that station personnel would attempt to modify the software coding. This was particularly true since most control and calculation functions could be accomplished using command software, and not actual computer programming.

In addition to the new buildings added to the system, station personnel have added a few points to the system on their own, where spares occurred in existing FIDS.

SFB:mct

PUGET SOUND NAVAL SHIPYARD

SITE VISIT NOTES

BREMERTON, WASHINGTON
AUGUST 18, 1983

ATTENDEES:

Steve Bruning	Newcomb & Boyd	(404) 352-3930
Jerry Milmont	Navy CEL	(805) 982-5778
Jim Sura	Puget Sound Naval Shipyard	(206) 476-3515

The original EMCS project at Puget Sound Naval Shipyard was installed in 1978, in the Industrial Waste Treatment Plant to provide control of primarily steam valves throughout the station. In 1980, an expansion project replaced all that system, and took over control of points from that system. An additional project is currently underway (Project P-223) which will pick-up additional buildings and added zones in the existing buildings. That project is currently under construction with a schedule calling for FID electronic installation approximately October of 1983, and completion in January 1984.

One problem with the P-223 contract was some buildings were dropped from the project because the S/I ratio was not over 1.0 in accordance with the criteria. This resulted from the artificially low electrical rate and is expected to be a problem, since electrical rates should be rising more rapidly than other fuel costs.

The work under Project P-223 is being performed by a local prime contractor with HSQ Technology as subcontractor. HSQ installed the existing system as prime contractor on the previous contract. Experience with HSQ personnel is that they have been very cooperative throughout both the original and current project. The specification for Project P-223 included a proprietary provision, calling for HSQ FIDS. The project was competitively bid with that provision in the spec, and six or seven bidders submitted prices. The low bid on the project was approximately \$475,000, and it was awarded in January, 1983.

As part of the current contract, some modifications were required of the existing application software, including the addition of energy metering software. The contract does call for the

Contractor to enter the database, but the station personnel gave a very detailed definition of the exact point data and application software data since they were intimately familiar with the format and software requirements. They did not include that data in the contract package, but clearly indicated that the Base would provide it. It took approximately two weeks of full time personnel effort to fill out the forms to provide the database to the Contractor.

The 1980 project (P-190) which installed the first portion of the HSQ system had heavy involvement on the part of PSNS personnel in helping HSQ finish the system start-up during the last four months of the contract. This involvement included both the field installation process and the central data entry process. This heavy involvement has proven very beneficial PSNS personnel. One problem that was encountered later is that some points were not tested on a point-by-point checkout basis. Subsequently, termination problems were discovered as the root of warranty difficulties.

As part of the current contract, an additional black and white CRT will be installed in Building 106, Central Power Plant. A CRT is also being installed in the Air Conditioning Foreman's Office. A CRT already is installed at the Trouble Call Foreman's Desk (this was added by the Base, after the original contract). Otherwise no central hardware changes are specified. The original system had a DEC PDP 11/34 central control unit, and a DEC 11/03 central communications controller. The existing CCC has four communication ports. HSQ have suggested getting rid of the 1103, and replacing it with XYCOM CCCs. This modification would improve the system response time. When the system was originally installed all analog points were included in a history capability of the system, and thus, some problems were encountered with system response time. PSNS personnel removed many of those points which were not needed for historical data recording and found substantial speed-up in system response time. The current concern is that when all additional points are added as part of the project, the existing CCC will not be able to handle within a reasonable response time. The Navy has indicated that their position is to wait and see whether this would slow down system response time.

Another problem encountered in the current contract is that all Contractor's submittals go to the A/E firm, and then copies are distributed once they are approved. The difficulty is that there are not enough copies specified for all parties involved so PSNS users do not receive a copy of the submittals. Specifications should require extra copies, to be provided to the user, particularly in a similar situation where the user already has the base

system and is very familiar with the system operation and requirements.

Another difficulty experienced at PSNS has to do with HVAC control interfaces in new construction. All during the P-190 EMCS contract new buildings were constructed at the base. After those buildings were completed, a change order was issued to HSQ to hook-up his FIDS to termination cabinets (installed by the original building contractor). The change order did not require HSQ to verify the point operation. It took approximately six weeks of PSNS personnel time to determine why those points did not work after HSQ hooked them up. The primary problem was control interfaces and sensors installed by the original building contractor were installed improperly, and since no tests have been specified as part of the building contract, those problems were never found. Therefore, any similar situation where sensors or controls are specified to be wired back to termination cabinet should include extensive testing as a part of that contract.

Other difficulties encountered at PSNS are a result of lack of documentation of changes by the ROICC construction personnel. One example encountered was in modifications to Building 437. That building received a new FID as part of the modification project including some basic control points. The modification contractor subcontracted back to HSQ to install the FID and terminate. The PSNS Electrical Shop was suppose to checkout the terminations. Once the building was in operation, complaints came from the user regarding the environmental controls. The contract called for control of the central building steam valve, but on investigation of the complaints, it was found that the main steam valve was never installed, and instead the Contractor connected the control to a single air handling unit's valve. This approach was a result of the ROICC office interpretation. From the time that interpretation was made, to the time the problem occurred, ROICC personnel had retired without documenting any of those changes. At this point, no one knows why the main steam control valve for the building, which was included in the construction contract, was never installed.

Another example of lack of enforcement occurred in Building 853 addition for Family Service Center. The existing building had an existing FID, which was to be expanded to serve the building addition. The expansion include seven to eight monitoring and control points. The contract did not call for the building contractor to make the connection from his installation to the FIDS, the Base personnel were suppose to do that. The building contractor was required to terminate on terminal strips outside the FID, so that Base personnel would then connect from those terminal strips into the FID. When personnel arrived to make

this connection, they found wiring hanging in the terminal strip cabinet completely unlabeled without any indication of what wire should be connected to what terminal. In addition, they found similar situations within parts of the HVAC control systems. The construction contract had already been accepted as complete by the ROICC office when these were found.

Even though HVAC control training is included as a standard part of NAVFAC specifications on large HVAC systems, Base personnel are not receiving that training when the building construction is complete because ROICC has not been enforcing that provision of the contract.

The expansion strategy in terms of additional building for PSNS is to specify HSQ FIDS to match existing as a part of the building construction project. That contract also includes loading of the database and checkout of the entire system.

FIDS stand alone capabilities were one of the weakest parts of the P-190 contract. Specifications were vague and the original implementation attempted to do very complicated stand alone functions in the FIDS. This resulted in great amount of difficulty without significant benefits because down-time (where the FID performed stand alone functions) has turned out to be very small. In the new contract, HSQ has solved many of the FID software problems, however, since the system has encountered so little communications and central equipment down-time, the Base philosophy is to perform only very simple functions in the FID, and use the FID stand alone simply as a fall back mode. This way, changes within the building do not require a complicated process of producing a new PROM each time.

Based on current quotations, prices for a fully populated FID are between \$6,000-\$8,000, not including point installation and labor. The Base personnel have actually built-up FID in one building by purchasing parts from XYCOM directly, and not HSQ.

The system is normally unmanned. Each morning, Electrical Shop personnel pick-up alarm printout from the previous evening and sort out which shops are responsible for which problems. During that normal shift operation, the system is used intermittently in the problem-solving process and for control fine tuning. This approach to use of the system is one reason for adding the terminal at the boiler plant so that alarms can be monitored continuously.

Over the past three years of operation, it is believed that the system has never been down for over four hours at a time. The central equipment is maintained under a contract with Digital

Equipment Corporation. Recently, some hardware problems have occurred with the central communications controller. This has brought to light some difficulty in "finger pointing" of DEC versus the HSQ supplied cards.

Regarding the user organizational structure, the energy conservation engineer works for the engineering division, and is responsible for system operation. He has an indirect line to the maintenance shop foreman, who actually maintains and operate the HVAC systems on the base. Under the P-180, 1978 contract for the replaced system, the system was under the Utilities Division. This was switched to the Maintenance Division, because Utilities are only responsible for systems up to the building line, and the EMCS primarily was used for controlling inside conditions of the building. At this time, the Utilities Division does not have anything to do with EMCS operation although all costs of the systems are transferred to the Utilities Division since the system is an energy saver.

In general, the Base is satisfied with application programs, except for the optimum start/stop program. That program is still not working very well at this site. HSQ is investigating to compare the program to other sites where the program is working. Base personnel don't feel that optimum start/stop is all that effective in the Bremerton climate.

Although there is a general feeling the EMCS has had very significant energy savings, no hard data is available to demonstrate those savings. The Shipyard utility costs fluctuate widely, depending on the ship remodeling workload, and other energy conservation projects have been installed at the same time as the EMCS. In terms of maintenance strategy, the Shipyard personnel trouble-shoot FID problems, and send those cards back to XYCOM for repair. Occasionally, Base personnel consult with HSQ regarding maintenance problems, and HSQ has been very cooperative, but HSQ is not actively involved in day to day maintenance.

The current EMCS project will add approximately 240 points to the system in twenty-three new buildings and in two buildings where FIDS are already installed. The contract does include installation of new steam control valves, and some steam repiping.

SFB:mct

NORFOLK NAVAL SHIPYARD

SITE VISIT NOTES

PORTSMOUTH, VIRGINIA
SEPTEMBER 12, 1983

ATTENDEES:

Steve Bruning	Newcom's & Boyd	(404) 352-3930
Jerry Milmont	Navy CEL	(805) 982-5778
Karlin Canfield	Navy CEL	(805) 982-3328
John Price	Norfolk Naval Shipyard	
Bill Williams	Norfolk Naval Shipyard	
Rod Riennerth	LANTDIV	(804) 444-9841
Richard Anderson	LANTDIV	(804) 444-9841

The EMCS at Norfolk Naval Shipyard consists of two computer systems. One system performs EMCS functions while the other system performs electrical system monitoring and control. Installation of the system was by HSQ Technology and has been completed and accepted by the Navy. Operator training sessions were in progress at the time of this site visit.

A post occupancy evaluation (POE) was performed on August 9 & 10. Copies of three documents related to that are attached. Attachment 1 are the handwritten notes made during the POE by the evaluation team from NAVFAC headquarters. Attachment 2 includes additional notes prepared by LANTDIV personnel relative to the POE. Attachment 3 provides copies of Shipyard (Bill Williams) comments presented at the August 9 & 10 POE.

In addition to the items covered in the above listed three attachments, the following items were discussed:

Implementation expertise is need to support start up of the EMCS by the Shipyard personnel. In particular, that expertise is needed relative to the energy conservation functions and implementation of such on the systems.

Significant problems have developed relative to the basic energy policy of the Navy. Insufficient support and emphasis on energy conservation have made implementation of the EMCS more difficult. Because of the lack of command emphasis, many problems have

occurred relative to occupant interference with the EMCS operation.

Plans are currently under way to retrofit or modify the EMCS installation to separate package system supply fans from refrigeration compressors. This will allow load shedding of the compressors without occupant knowledge.

Currently the EMCS is operated under the Utilities Division. The shipyard has an energy coordinator who is under the Planning Department; however the EMCS is under the Operation and Maintenance Department. All of these groups are under the Public Works Officer and do not directly work for the shipyard commander. This organization has lead to a lack of command emphasis on EMCS implementation.

Currently no support facilities have been allocated for the EMCS shop. No transportation, communications, spare parts, etc. are allocated for the EMCS shop. In addition, no standard within the Navy exist for rating technicians within the EMCS shop and this has caused difficulty in hiring properly qualified maintenance technicians for the shop.

Three additional buildings will be connected to the EMCS by Shipyard personnel. Three other buildings are being added to the system by HSQ Technology under change order.

Difficulties with the contractor were discussed. The general attitude of the contractor at times was to not perform any more work than he was forced to, whether or not it is included in the contract. There is currently a concern that expansion of the system may be a problem due to technical limitations of some of the communications equipment installed by the contractor. However, because documentation is only now being received, that potential problem has not been able to be investigated properly.

One problem that occurred in utilizing the system related to steam trap operation during intermediate seasons. When the steam systems were shut down overnight, difficulties were encountered in getting condensate out of the system on start up. Many of the problems were due to steam trap maintenance problems which are being reported to maintenance shops.

The original design drawings call for the use of strap on aquastats to indicate steam supply system status. Due to the installation of the aquastats adjacent to the control steam valve, the aquastats were very slow to respond if at all. Based on that status being indicated, sometimes buildings were not started up by the EMCS and thus caused occupant discomfort.

Currently the Shipyard is ordering pressure switches to be installed on existing gauge taps downstream of the control steam valves. This should provide a more positive indication of steam system status.

Much of the documentation provided with the system was not felt to be adequate. That documentation will be updated as a part of the current change order. The change order will upgrade the existing PDP11/34 computers to PDP 11/24 computers with one megabyte of memory to improve overall system performance.

SFB:bag

NAVY PROCESSING FACILITY

SITE VISIT NOTES

DAM NECK, VIRGINIA
SEPTEMBER 13, 1983

ATTENDEES:

Steve Bruning	Newcomb & Boyd	(404) 352-3930
Jerry Milmont	Navy CEL	(805) 982-5778
Karlin Canfield	Navy CEL	(805) 982-3328
George Novey	LANTDIV NAVFAC	(804) 444-9841
Steve Dumont	LANTDIV NAVFAC	(804) 444-9841
Lt. Hamilton	Navy Processing Facility	

The EMCS for the Navy Processing Facility is approaching the end of the 30-day acceptance test. Engineered Sales Service, Inc. (ESSI) is the prime contractor for the EMCS project. Initially, ESSI attempted to install a RADIX EMCS. A number of problems were encountered with the system and the contractor was not able to resolve those. The project was originally started in 1978. In 1982, the contractor decided to terminate RADIX and proposed a Barber-Coleman ECON VI System. The Navy accepted this proposal and that is the system that is currently at the end of its 30-day acceptance test period.

The EMCS includes a Winchester disk drive, 8" floppy disk drive, a Computer Automation computer, and multiple operating stations consisting of black and white CRTs and printers.

The building is a high security computer facility with 24-hour operation. Due to this function, many of the energy conservation features of the EMCS are not implemented, however they have been provided with the system. The system includes a "custom control action" software package to perform the algorithmic control sequence function of the specification. This software has been used extensively in implementing the system. In addition to the operator console located adjacent to the computer, a second console is installed at the separate mechanical/electrical utility building. The computer for the system is located in a computer room along with the primary operator station. The system is connected to approximately 700 points and is sized such that it can be expanded to add approximately 300 more points without any hardware additions. The system can be expanded

beyond the 1000 point level with some additional hardware.

Currently (during the 30-day test) the duty cycle program, optimum start/stop program, and other energy conservation programs are being utilized on HVAC systems controlling an area of the building which has not yet been occupied by computer equipment. This is being done to test software during the 30-day test period. Once that 30-day test is completed, and the area of the building is occupied, those functions will not be performed.

In addition to the two operators' stations mentioned, an alarm printer is provided at the watch officers desk for night operation.

The primary function of the system will be to provide monitoring and alarm capabilities and to rotate operation among the large number of air handling system which have been provided for redundancy and future capacity serving the computer spaces. On failure of a particular air system, the EMCS will be used to start the standby systems on detection of that failure. The chiller plant is monitored extensively by the EMCS, however, manual valving is used between the various machines and therefore the EMCS cannot perform chiller plant optimization. The system is also used for temperature and humidity profile monitoring of the computer spaces themselves.

The system is not manned continuously. Three people had been trained as its primary operators and four electronics technicians had been trained relative to service of the system. None of those personnel are completely dedicated to operation or use of the EMCS.

The EMCS project was bid separately after the building contract was awarded. ESSI was the controls contractor for the building construction contract and subsequently won the separate bid for the EMCS contract. All sensors and control interfaces were installed as a part of the original contract and wired back to data terminal cabinets. All sensors are pneumatic and were installed as part of the original building contract. The original contract called for pneumatic sensors connected to the interface cabinet and included transducers to convert the pneumatic sensor signals to a 4 to 20 miliampere signal connected to a terminal strip. The EMCS would then connect to the terminal strip. This was done based on existing maintenance personnel staffing at the base. Subsequently the activity assumed the task.

The system is not a distributed processing, stand alone field unit type system due to its all being installed in a single

building. The multiplexer panels do some communications/engineering unit conversion and do "report-by-exception". They do not include any stand alone applications software functions.

Once ESSI removed the RADIX installation and got approval to install the Barber-Coleman ECON VI System, it took approximately three months to install the system. The basic specification used for the original EMCS contract was met by the ECON VI System (with the exception of color graphics included in the original specification). That requirement had been relaxed in the original contract because RADIX claimed that color graphics could not be performed using floppy diskettes, which were the only disk memory specified in the original contract. The Navy felt that the graphics system was not necessary for the use planned for the system and would simply add more cost to maintain and implement the system.

The system is capable of resetting all thermostats (pneumatic controllers) from the central console.

ESSI has done an excellent job of providing detailed as-built wiring diagrams of the system and has been very cooperative through-out the entire project.

SFB:bag

LANGLEY AIR FORCE BASE

SITE VISIT NOTES

HAMPTON, VIRGINIA
SEPTEMBER 15, 1983

ATTENDEES:

Steve Bruning	Newcomb & Boyd	(404) 352-3930
Karlin Canfield	Navy CEL	(805) 982-3328
Tom White	Headquarters Tactical	
	Air Command	(804) 764-3237

The attached notes from a staff visit to Langley Air Force Base dated 22 July 1983 were provided by Tom White and discussed. The system installed is a Honeywell Delta 5600 System. The system is operational and has passed the acceptance test. The contract still has not been concluded due to some outstanding items on the punch list. Two main items felt to be lacking on the system at this time. Some of the documentation has not yet been delivered by Honeywell and the system capabilities are not being fully utilized by Air Force personnel. The attached staff visit notes document these items.

SFB:bag

APPENDIX F - FOLLOW-UP INVESTIGATION SITE VISIT ATTACHMENTS

1. Norfolk Naval Shipyard - Post Occupancy Evaluation Field Notes
2. Norfolk Naval Shipyard - Additional Post Occupancy Evaluation Comments
3. Norfolk Naval Shipyard - Post Occupancy Evaluation Station Comments
4. Langley Air Force Base -

POST OCCUPANCY EVALUATION OF

DEFICIENCY NO. 1 :

①

Documentation for MTL not received -
Required for Shipyard to do in-house expansions

1. THIS DEFICIENCY IS CONSIDERED TO BE:

☐ (A.) SPONSOR'S PLANNING DEFICIENCY

☐ (B.) CRITERIA DEFICIENCY
 1. DESIGN MANUAL
 2. GUIDE SPECS
 3. DEFINITIVE DRAWING

☐ (C.) DESIGN DEFICIENCY

☐ (D.) CONSTRUCTION DEFICIENCY

☐ (E.) COLLATERAL EQUIPMENT DEFICIENCY

☐ (F.) MAINTENANCE DEFICIENCY

☒ (G.) OTHER Documents to be furnished by Contractor
2. THIS DEFICIENCY, IN THIS PROJECT, (~~HAS BEEN~~), (SHOULD BE) CORRECTED BY:
☐ (A.) APPROPRIATE FUNDS

☐ (B.) WARRANTY

☐ (C.) NO CORRECTION (POSSIBLE) (NEEDED)

☒ (D.) OTHER Contractor to supply

3. IN FUTURE PROJECTS, THIS DEFICIENCY (HAS BEEN) (SHOULD BE) AVOIDED BY:

☐ (A.) REVISION TO SPONSOR'S PLANNING DATA

☐ (B.) BETTER PLANS AND SPECS

☐ (C.) REVISION TO NAVFAC CRITERIA

☐ (D.) BETTER INSPECTION

☐ (E.) BETTER COORDINATION OF COLLATERAL EQUIPMENT

☐ (F.) BETTER PREVENTIVE MAINTENANCE

☒ (G.) NOT APPLICABLE
SPECIFIC RECOMMENDATIONS

FOR SUBJECT PROJECT:

Work with Contractor to ensure
documentation is provided

FOR FUTURE PROJECTS:

Set up documentation cost schedule

①

POST OCCUPANCY EVALUATION OF

DEFICIENCY NO. 2 : As Built drawings not received

1. THIS DEFICIENCY IS CONSIDERED TO BE:

- ☐ (A.) SPONSOR'S PLANNING DEFICIENCY
- ☐ (B.) CRITERIA DEFICIENCY
1. DESIGN MANUAL
2. GUIDE SPECS
3. DEFINITIVE DRAWING
- ☐ (C.) DESIGN DEFICIENCY
- ☐ (D.) CONSTRUCTION DEFICIENCY
- ☐ (E.) COLLATERAL EQUIPMENT DEFICIENCY
- ☐ (F.) MAINTENANCE DEFICIENCY
- ☒ (G.) OTHER Documents to be furnished by Contractor

2. THIS DEFICIENCY, IN THIS PROJECT, ~~(DEFICIENCY)~~, (SHOULD BE) CORRECTED BY:

- ☐ (A.) APPROPRIATE FUNDS
- ☐ (B.) WARRANTY
- ☐ (C.) NO CORRECTION (POSSIBLE) (NEEDED)
- ☒ (D.) OTHER Contractor to Supply

3. IN FUTURE PROJECTS, THIS DEFICIENCY (HAS BEEN) (SHOULD BE) AVOIDED BY:

- ☐ (A.) REVISION TO SPONSOR'S PLANNING DATA
- ☐ (B.) BETTER PLANS AND SPECS
- ☐ (C.) REVISION TO NAVFAC CRITERIA _____
- ☐ (D.) BETTER INSPECTION
- ☐ (E.) BETTER COORDINATION OF COLLATERAL EQUIPMENT
- ☐ (F.) BETTER PREVENTIVE MAINTENANCE
- ☒ (G.) NOT APPLICABLE

SPECIFIC RECOMMENDATIONS

FOR SUBJECT PROJECT: _____

FOR FUTURE PROJECTS: Set Up documentation cost schedule.

①

POST OCCUPANCY EVALUATION OF

DEFICIENCY NO. 3

*FID locations - some very poor due to humidity -
temperature. Shield is relocated or environmentally protected.*

1. THIS DEFICIENCY IS CONSIDERED TO BE:

- ☐ (A) SPONSOR'S PLANNING DEFICIENCY
- ☐ (B) CRITERIA DEFICIENCY
1. DESIGN MANUAL
2. GUIDE SPECS
3. DEFINITIVE DRAWING
- ☒ (C) DESIGN DEFICIENCY
- ☐ (D) CONSTRUCTION DEFICIENCY
- ☐ (E) COLLATERAL EQUIPMENT DEFICIENCY
- ☐ (F) MAINTENANCE DEFICIENCY
- ☐ (G) OTHER _____

2. THIS DEFICIENCY, IN THIS PROJECT, (HAS BEEN), (SHOULD BE) CORRECTED BY:

- ☐ (A) APPROPRIATE FUNDS
- ☐ (B) WARRANTY
- ☒ (C) NO CORRECTION ~~(NEEDED)~~ (NEEDED)
- ☐ (D) OTHER _____

3. IN FUTURE PROJECTS, THIS DEFICIENCY ~~(HAS BEEN)~~ (SHOULD BE) AVOIDED BY:

- ☐ (A) REVISION TO SPONSOR'S PLANNING DATA
- ☐ (B) BETTER PLANS AND SPECS
- ☒ (C) REVISION TO NAVFAC CRITERIA _____
- ☐ (D) BETTER INSPECTION
- ☐ (E) BETTER COORDINATION OF COLLATERAL EQUIPMENT
- ☐ (F) BETTER PREVENTIVE MAINTENANCE
- ☐ (G) NOT APPLICABLE

SPECIFIC RECOMMENDATIONS

FOR SUBJECT PROJECT: _____

FOR FUTURE PROJECTS: _____

①

POST OCCUPANCY EVALUATION OF

DEFICIENCY NO. 4 : FID's battery backup (5V & 12V) only for
communications program - no 24V backup for operations.

1. THIS DEFICIENCY IS CONSIDERED TO BE:

☐ (A) SPONSOR'S PLANNING DEFICIENCY

☐ (B) CRITERIA DEFICIENCY
 1. DESIGN MANUAL
 2. GUIDE SPECS
 3. DEFINITIVE DRAWING

Delete

☐ (C) DESIGN DEFICIENCY

☐ (D) CONSTRUCTION DEFICIENCY

☐ (E) COLLATERAL EQUIPMENT DEFICIENCY

☐ (F) MAINTENANCE DEFICIENCY

☐ (G) OTHER _____

2. THIS DEFICIENCY, IN THIS PROJECT, (HAS BEEN), (SHOULD BE) CORRECTED BY:

☐ (A) APPROPRIATE FUNDS

☐ (B) WARRANTY

☐ (C) NO CORRECTION (POSSIBLE) (NEEDED)

☐ (D) OTHER _____

3. IN FUTURE PROJECTS, THIS DEFICIENCY (HAS BEEN) (SHOULD BE) AVOIDED BY:

☐ (A) REVISION TO SPONSOR'S PLANNING DATA

☐ (B) BETTER PLANS AND SPECS

☐ (C) REVISION TO NAVFAC CRITERIA _____

☐ (D) BETTER INSPECTION

☐ (E) BETTER COORDINATION OF COLLATERAL EQUIPMENT

☐ (F) BETTER PREVENTIVE MAINTENANCE

☐ (G) NOT APPLICABLE

SPECIFIC RECOMMENDATIONS

FOR SUBJECT PROJECT: _____

FOR FUTURE PROJECTS: _____

(1)

POST OCCUPANCY EVALUATION OF

DEFICIENCY NO. 5 : 3 Buildings not on system due to lack of government furnished telephone lines

1. THIS DEFICIENCY IS CONSIDERED TO BE:

☐ (A) SPONSOR'S PLANNING DEFICIENCY

☐ (B) CRITERIA DEFICIENCY
 1. DESIGN MANUAL
 2. GUIDE SPECS
 3. DEFINITIVE DRAWING

☐ (C) DESIGN DEFICIENCY

☐ (D) CONSTRUCTION DEFICIENCY

☐ (E) COLLATERAL EQUIPMENT DEFICIENCY

☐ (F) MAINTENANCE DEFICIENCY

☒ (G) OTHER No Facilities available to isolated site

2. THIS DEFICIENCY, IN THIS PROJECT, (HAS BEEN), (SHOULD BE) CORRECTED BY:

☒ (A) APPROPRIATE FUNDS

☐ (B) WARRANTY

☐ (C) NO CORRECTION (POSSIBLE) (NEEDED)

☐ (D) OTHER _____

3. IN FUTURE PROJECTS, THIS DEFICIENCY ~~HAS BEEN~~ (SHOULD BE) AVOIDED BY:

☐ (A) REVISION TO SPONSOR'S PLANNING DATA

☒ (B) BETTER PLANS AND SPECS

☐ (C) REVISION TO NAVFAC CRITERIA _____

☐ (D) BETTER INSPECTION

☐ (E) BETTER COORDINATION OF COLLATERAL EQUIPMENT

☐ (F) BETTER PREVENTIVE MAINTENANCE

☐ (G) NOT APPLICABLE

SPECIFIC RECOMMENDATIONS

FOR SUBJECT PROJECT: _____

FOR FUTURE PROJECTS: Ensure plans only reflect possible work.

(1)

POST OCCUPANCY EVALUATION OF

DEFICIENCY NO. 6 : *Pressure Reducing Valves - Steam - control piping & valves materials and assembly method insufficient*

1. THIS DEFICIENCY IS CONSIDERED TO BE:

- ☐ (A) SPONSOR'S PLANNING DEFICIENCY
- ☐ (B) CRITERIA DEFICIENCY
1. DESIGN MANUAL
2. GUIDE SPECS
3. DEFINITIVE DRAWING
- ☒ (C) DESIGN DEFICIENCY
- ☐ (D) CONSTRUCTION DEFICIENCY
- ☐ (E) COLLATERAL EQUIPMENT DEFICIENCY
- ☐ (F) MAINTENANCE DEFICIENCY
- ☐ (G) OTHER _____

2. THIS DEFICIENCY, IN THIS PROJECT, (HAS BEEN), ~~(SHOULD BE)~~ CORRECTED BY:

- ☐ (A) APPROPRIATE FUNDS
- ☐ (B) WARRANTY
- ☒ (C) NO CORRECTION ~~(NEEDED)~~ (NEEDED)
- ☒ (D) OTHER _____

3. IN FUTURE PROJECTS, THIS DEFICIENCY (HAS BEEN) (SHOULD BE) AVOIDED BY:

- ☐ (A) REVISION TO SPONSOR'S PLANNING DATA
- ☒ (B) BETTER PLANS AND SPECS
- ☐ (C) REVISION TO NAVFAC CRITERIA _____
- ☐ (D) BETTER INSPECTION
- ☐ (E) BETTER COORDINATION OF COLLATERAL EQUIPMENT
- ☐ (F) BETTER PREVENTIVE MAINTENANCE
- ☐ (G) NOT APPLICABLE

SPECIFIC RECOMMENDATIONS

FOR SUBJECT PROJECT:

Piping specs did not include required details for instrument piping. Shop drawings should be more complete.

FOR FUTURE PROJECTS:

Pay more attention to these requirements. Provide Shop Drawings -

①

POST OCCUPANCY EVALUATION OF

DEFICIENCY NO. 7 : Pressure Regulating Valves - Steam - control piping insulation requirements not called out

1. THIS DEFICIENCY IS CONSIDERED TO BE:

- ☐ (A.) SPONSOR'S PLANNING DEFICIENCY
☒ (B.) CRITERIA DEFICIENCY
 1. DESIGN MANUAL
 2. GUIDE SPECS
 3. DEFINITIVE DRAWING
☒ (C.) DESIGN DEFICIENCY
☐ (D.) CONSTRUCTION DEFICIENCY
☐ (E.) COLLATERAL EQUIPMENT DEFICIENCY
☐ (F.) MAINTENANCE DEFICIENCY
☐ (G.) OTHER _____

2. THIS DEFICIENCY, IN THIS PROJECT, ~~HAS BEEN~~, (SHOULD BE) CORRECTED BY:

- ☐ (A.) APPROPRIATE FUNDS
☐ (B.) WARRANTY
☒ (C.) NO CORRECTION (~~POSSIBLE~~) (NEEDED)
☐ (D.) OTHER _____

3. IN FUTURE PROJECTS, THIS DEFICIENCY ~~HAS BEEN~~ (SHOULD BE) AVOIDED BY:

- ☐ (A.) REVISION TO SPONSOR'S PLANNING DATA
☒ (B.) BETTER PLANS AND SPECS
☐ (C.) REVISION TO NAVFAC CRITERIA _____
☐ (D.) BETTER INSPECTION
☐ (E.) BETTER COORDINATION OF COLLATERAL EQUIPMENT
☐ (F.) BETTER PREVENTIVE MAINTENANCE
☐ (G.) NOT APPLICABLE

SPECIFIC RECOMMENDATIONS

FOR SUBJECT PROJECT: _____

FOR FUTURE PROJECTS: Attention paid to properly insulating accessible. Control piping or exposed to cold environment. (1)

POST OCCUPANCY EVALUATION OF

(DEFICIENCY NO. 8 : Chiller Management Software missing)

1. THIS DEFICIENCY IS CONSIDERED TO BE:

- ☐ (A) SPONSOR'S PLANNING DEFICIENCY
- ☐ (B) CRITERIA DEFICIENCY
1. DESIGN MANUAL
2. GUIDE SPECS
3. DEFINITIVE DRAWING
- ☐ (C) DESIGN DEFICIENCY
- ☒ (D) CONSTRUCTION DEFICIENCY
- ☐ (E) COLLATERAL EQUIPMENT DEFICIENCY
- ☐ (F) MAINTENANCE DEFICIENCY
- ☐ (G) OTHER _____

2. THIS DEFICIENCY, IN THIS PROJECT, ~~(DEFICIENCY)~~, (SHOULD BE) CORRECTED BY:

- ☐ (A) APPROPRIATE FUNDS
- ☐ (B) WARRANTY
- ☐ (C) NO CORRECTION (POSSIBLE) (NEEDED)
- ☒ (D) OTHER ROICC HAS REQUESTED Software from Contractor

3. IN FUTURE PROJECTS, THIS DEFICIENCY ~~(DEFICIENCY)~~ (SHOULD BE) AVOIDED BY:

- ☐ (A) REVISION TO SPONSOR'S PLANNING DATA
- ☐ (B) BETTER PLANS AND SPECS
- ☐ (C) REVISION TO NAVFAC CRITERIA _____
- ☐ (D) BETTER INSPECTION
- ☐ (E) BETTER COORDINATION OF COLLATERAL EQUIPMENT
- ☐ (F) BETTER PREVENTIVE MAINTENANCE
- ☒ (G) NOT APPLICABLE

SPECIFIC RECOMMENDATIONS

FOR SUBJECT PROJECT: _____

FOR FUTURE PROJECTS: _____

(1)

POST OCCUPANCY EVALUATION OF

DEFICIENCY NO. 9: Temperature/enthalpy control program
software not ~~present~~ available

1. THIS DEFICIENCY IS CONSIDERED TO BE:

- ☐ (A) SPONSOR'S PLANNING DEFICIENCY
☐ (B) CRITERIA DEFICIENCY
 1. DESIGN MANUAL
 2. GUIDE SPECS
 3. DEFINITIVE DRAWING

- ☐ (C) DESIGN DEFICIENCY
☐ (D) CONSTRUCTION DEFICIENCY
☐ (E) COLLATERAL EQUIPMENT DEFICIENCY
☐ (F) MAINTENANCE DEFICIENCY
☒ (G) OTHER Called for in specs.

2. THIS DEFICIENCY, IN THIS PROJECT, ~~is not~~ (SHOULD BE) CORRECTED BY:

- ☐ (A) APPROPRIATE FUNDS
☐ (B) WARRANTY
☒ (C) NO CORRECTION ~~(NEEDED)~~ (NEEDED)
☐ (D) OTHER _____

3. IN FUTURE PROJECTS, THIS DEFICIENCY (HAS BEEN) (SHOULD BE) AVOIDED BY:

- ☐ (A) REVISION TO SPONSOR'S PLANNING DATA
☐ (B) BETTER PLANS AND SPECS
☐ (C) REVISION TO NAVFAC CRITERIA _____
☐ (D) BETTER INSPECTION
☐ (E) BETTER COORDINATION OF COLLATERAL EQUIPMENT
☐ (F) BETTER PREVENTIVE MAINTENANCE
☐ (G) NOT APPLICABLE

RECOMMENDATIONS

PROJECT PROJECT: P-5 Ambiguities & no current need for it

OTHER PROJECTS: Insist on soft ware if required by P-5 (1)
as it is not available in the project.

POST OCCUPANCY EVALUATION OF

DEFICIENCY NO. 10 :

Dynamic Energy Display softwarenot provided

1. THIS DEFICIENCY IS CONSIDERED TO BE:

☐ (A) SPONSOR'S PLANNING DEFICIENCY☐ (B) CRITERIA DEFICIENCY
1. DESIGN MANUAL
2. GUIDE SPECS
3. DEFINITIVE DRAWING*Delete*☐ (C) DESIGN DEFICIENCY☐ (D) CONSTRUCTION DEFICIENCY☐ (E) COLLATERAL EQUIPMENT DEFICIENCY☐ (F) MAINTENANCE DEFICIENCY☐ (G) OTHER _____

2. THIS DEFICIENCY, IN THIS PROJECT, (HAS BEEN), (SHOULD BE) CORRECTED BY:

☐ (A) APPROPRIATE FUNDS☐ (B) WARRANTY☐ (C) NO CORRECTION (POSSIBLE) (NEEDED)☐ (D) OTHER _____

3. IN FUTURE PROJECTS, THIS DEFICIENCY (HAS BEEN) (SHOULD BE) AVOIDED BY:

☐ (A) REVISION TO SPONSOR'S PLANNING DATA☐ (B) BETTER PLANS AND SPECS☐ (C) REVISION TO NAVFAC CRITERIA _____☐ (D) BETTER INSPECTION☐ (E) BETTER COORDINATION OF COLLATERAL EQUIPMENT☐ (F) BETTER PREVENTIVE MAINTENANCE☐ (G) NOT APPLICABLESPECIFIC RECOMMENDATIONS

FOR SUBJECT PROJECT: _____

FOR FUTURE PROJECTS: _____

(1)

POST OCCUPANCY EVALUATION OF

DEFICIENCY NO. 11 : Boiler Management software missing

1. THIS DEFICIENCY IS CONSIDERED TO BE:

- ☐ (A) SPONSOR'S PLANNING DEFICIENCY
- ☐ (B) CRITERIA DEFICIENCY
1. DESIGN MANUAL
2. GUIDE SPECS
3. DEFINITIVE DRAWING
- ☐ (C) DESIGN DEFICIENCY
- ☒ (D) CONSTRUCTION DEFICIENCY
- ☐ (E) COLLATERAL EQUIPMENT DEFICIENCY
- ☐ (F) MAINTENANCE DEFICIENCY
- ☐ (G) OTHER _____

2. THIS DEFICIENCY, IN THIS PROJECT, ~~(HAS BEEN)~~, (SHOULD BE) CORRECTED BY:

- ☐ (A) APPROPRIATE FUNDS
- ☐ (B) WARRANTY
- ☐ (C) NO CORRECTION (POSSIBLE) (NEEDED)
- ☒ (D) OTHER RCICC ^{HAS} REQUESTED CONTRACTOR TO SERVICE

3. IN FUTURE PROJECTS, THIS DEFICIENCY ~~(HAS BEEN)~~ (SHOULD BE) AVOIDED BY:

- ☐ (A) REVISION TO SPONSOR'S PLANNING DATA
- ☐ (B) BETTER PLANS AND SPECS
- ☐ (C) REVISION TO NAVFAC CRITERIA _____
- ☐ (D) BETTER INSPECTION
- ☐ (E) BETTER COORDINATION OF COLLATERAL EQUIPMENT
- ☐ (F) BETTER PREVENTIVE MAINTENANCE
- ☒ (G) NOT APPLICABLE

SPECIFIC RECOMMENDATIONS

FOR SUBJECT PROJECT: _____

FOR FUTURE PROJECTS: Data Base Coordination should be started during design (1)

POST OCCUPANCY EVALUATION OF

DEFICIENCY NO. 12: ~~Deficiency~~ ^{and schedule - new parts} ~~staff~~ required on site by contractor
~~not defined - USAF base contract AAF~~

1. THIS DEFICIENCY IS CONSIDERED TO BE:

- ☐ (A) SPONSOR'S PLANNING DEFICIENCY
- ☒ (B) CRITERIA DEFICIENCY
1. DESIGN MANUAL
 2. GUIDE SPECS
 3. DEFINITIVE DRAWING

- ☒ (C) DESIGN DEFICIENCY
- ☐ (D) CONSTRUCTION DEFICIENCY
- ☐ (E) COLLATERAL EQUIPMENT DEFICIENCY
- ☐ (F) MAINTENANCE DEFICIENCY
- ☐ (G) OTHER _____

2. THIS DEFICIENCY, IN THIS PROJECT, ~~was not~~, (SHOULD BE) CORRECTED BY:

- ☐ (A) APPROPRIATE FUNDS
- ☐ (B) WARRANTY
- ☐ (C) NO CORRECTION (POSSIBLE) (NEEDED)
- ☒ (D) OTHER Contract enforcement

3. IN FUTURE PROJECTS, THIS DEFICIENCY ~~was not~~ (SHOULD BE) AVOIDED BY:

- ☐ (A) REVISION TO SPONSOR'S PLANNING DATA
- ☒ (B) BETTER PLANS AND SPECS
- ☒ (C) REVISION TO NAVFAC CRITERIA _____
- ☐ (D) BETTER INSPECTION
- ☐ (E) BETTER COORDINATION OF COLLATERAL EQUIPMENT
- ☐ (F) BETTER PREVENTIVE MAINTENANCE
- ☐ (G) NOT APPLICABLE

SPECIFIC RECOMMENDATIONS

FOR SUBJECT PROJECT:

Better maintenance by Contractor

FOR FUTURE PROJECTS:

Better specific requirement

(1)

POST OCCUPANCY EVALUATION OF

DEFICIENCY NO. 13 : Preventive maintenance schedules not well defined in specs.

1. THIS DEFICIENCY IS CONSIDERED TO BE:

- ☐ (A) SPONSOR'S PLANNING DEFICIENCY
- ☐ (B) CRITERIA DEFICIENCY
1. DESIGN MANUAL
2. GUIDE SPECS
3. DEFINITIVE DRAWING

- ☐ (C) DESIGN DEFICIENCY
- ☐ (D) CONSTRUCTION DEFICIENCY
- ☐ (E) COLLATERAL EQUIPMENT DEFICIENCY
- ☐ (F) MAINTENANCE DEFICIENCY
- ☐ (G) OTHER _____

Deleted - combined with #12

2. THIS DEFICIENCY, IN THIS PROJECT, (HAS BEEN), (SHOULD BE) CORRECTED BY:

- ☐ (A) APPROPRIATE FUNDS
- ☐ (B) WARRANTY
- ☐ (C) NO CORRECTION (POSSIBLE) (NEEDED)
- ☐ (D) OTHER _____

3. IN FUTURE PROJECTS, THIS DEFICIENCY (HAS BEEN) (SHOULD BE) AVOIDED BY:

- ☐ (A) REVISION TO SPONSOR'S PLANNING DATA
- ☐ (B) BETTER PLANS AND SPECS
- ☐ (C) REVISION TO NAVFAC CRITERIA _____
- ☐ (D) BETTER INSPECTION
- ☐ (E) BETTER COORDINATION OF COLLATERAL EQUIPMENT
- ☐ (F) BETTER PREVENTIVE MAINTENANCE
- ☐ (G) NOT APPLICABLE

SPECIFIC RECOMMENDATIONS

FOR SUBJECT PROJECT: _____

FOR FUTURE PROJECTS: _____

POST OCCUPANCY EVALUATION OF

DEFICIENCY NO. 14 : No Alarms given on lack of airflow from AHU
when chiller temperatures indicate AHU should operate (Schematic 6,
Bldg 9, AHU 3)

1. THIS DEFICIENCY IS CONSIDERED TO BE:

- ☐ (A.) SPONSOR'S PLANNING DEFICIENCY
- ☐ (B.) CRITERIA DEFICIENCY
1. DESIGN MANUAL
2. GUIDE SPECS
3. DEFINITIVE DRAWING
- ☐ (C.) DESIGN DEFICIENCY
- ☐ (D.) CONSTRUCTION DEFICIENCY
- ☐ (E.) COLLATERAL EQUIPMENT DEFICIENCY
- ☐ (F.) MAINTENANCE DEFICIENCY
- ☐ (G.) OTHER _____

*Delete - Not
a problem*

2. THIS DEFICIENCY, IN THIS PROJECT, (HAS BEEN), (SHOULD BE) CORRECTED BY:

- ☐ (A.) APPROPRIATE FUNDS
- ☐ (B.) WARRANTY
- ☐ (C.) NO CORRECTION (POSSIBLE) (NEEDED)
- ☐ (D.) OTHER _____

3. IN FUTURE PROJECTS, THIS DEFICIENCY (HAS BEEN) (SHOULD BE) AVOIDED BY:

- ☐ (A.) REVISION TO SPONSOR'S PLANNING DATA
- ☐ (B.) BETTER PLANS AND SPECS
- ☐ (C.) REVISION TO NAVFAC CRITERIA _____
- ☐ (D.) BETTER INSPECTION
- ☐ (E.) BETTER COORDINATION OF COLLATERAL EQUIPMENT
- ☐ (F.) BETTER PREVENTIVE MAINTENANCE
- ☐ (G.) NOT APPLICABLE

SPECIFIC RECOMMENDATIONS

FOR SUBJECT PROJECT: _____

FOR FUTURE PROJECTS: _____

(1)

POST OCCUPANCY EVALUATION OF

DEFICIENCY NO. 15: C&M management poorly defined in criteria -
Min-Max Limits, spare parts on hand, etc.

1. THIS DEFICIENCY IS CONSIDERED TO BE:

- ☐ (A) SPONSOR'S PLANNING DEFICIENCY
- ☐ (B) CRITERIA DEFICIENCY
1. DESIGN MANUAL
2. GUIDE SPECS
3. DEFINITIVE DRAWING
- ☐ (C) DESIGN DEFICIENCY
- ☐ (D) CONSTRUCTION DEFICIENCY
- ☐ (E) COLLATERAL EQUIPMENT DEFICIENCY
- ☐ (F) MAINTENANCE DEFICIENCY
- ☐ (G) OTHER _____

Delete - Combined
with #12.

2. THIS DEFICIENCY, IN THIS PROJECT, (HAS BEEN), (SHOULD BE) CORRECTED BY:

- ☐ (A) APPROPRIATE FUNDS
- ☐ (B) WARRANTY
- ☐ (C) NO CORRECTION (POSSIBLE) (NEEDED)
- ☐ (D) OTHER _____

3. IN FUTURE PROJECTS, THIS DEFICIENCY (HAS BEEN) (SHOULD BE) AVOIDED BY:

- ☐ (A) REVISION TO SPONSOR'S PLANNING DATA
- ☐ (B) BETTER PLANS AND SPECS
- ☐ (C) REVISION TO NAVFAC CRITERIA _____
- ☐ (D) BETTER INSPECTION
- ☐ (E) BETTER COORDINATION OF COLLATERAL EQUIPMENT
- ☐ (F) BETTER PREVENTIVE MAINTENANCE
- ☐ (G) NOT APPLICABLE

SPECIFIC RECOMMENDATIONS

FOR SUBJECT PROJECT: _____

FOR FUTURE PROJECTS: _____

(1)

POST OCCUPANCY EVALUATION OF

DEFICIENCY NO. 16 : AQUASTATS used downstream of PRV's mis -
applied. Max. RATING 200°F - ACTUAL STEAM TEMP 325°F.

1. THIS DEFICIENCY IS CONSIDERED TO BE:

- ☐ (A.) SPONSOR'S PLANNING DEFICIENCY
- ☐ (B.) CRITERIA DEFICIENCY
1. DESIGN MANUAL
 2. GUIDE SPECS
 3. DEFINITIVE DRAWING

- ☒ (C.) DESIGN DEFICIENCY
- ☐ (D.) CONSTRUCTION DEFICIENCY
- ☐ (E.) COLLATERAL EQUIPMENT DEFICIENCY
- ☐ (F.) MAINTENANCE DEFICIENCY
- ☐ (G.) OTHER _____

2. THIS DEFICIENCY, IN THIS PROJECT, ~~HAS BEEN~~, (SHOULD BE) CORRECTED BY:

- ☒ (A.) APPROPRIATE FUNDS
- ☐ (B.) WARRANTY
- ☐ (C.) NO CORRECTION (POSSIBLE) (NEEDED)
- ☐ (D.) OTHER _____

3. IN FUTURE PROJECTS, THIS DEFICIENCY (~~HAS BEEN~~) (SHOULD BE) AVOIDED BY:

- ☐ (A.) REVISION TO SPONSOR'S PLANNING DATA
- ☒ (B.) BETTER PLANS AND SPECS
- ☐ (C.) REVISION TO NAVFAC CRITERIA _____
- ☐ (D.) BETTER INSPECTION
- ☐ (E.) BETTER COORDINATION OF COLLATERAL EQUIPMENT
- ☐ (F.) BETTER PREVENTIVE MAINTENANCE
- ☐ (G.) NOT APPLICABLE

SPECIFIC RECOMMENDATIONS

FOR SUBJECT PROJECT: _____

FOR FUTURE PROJECTS: _____

(1)

POST OCCUPANCY EVALUATION OF

DEFICIENCY NO. 17 : Contractor argues spec's do not require him to load data base.

1. THIS DEFICIENCY IS CONSIDERED TO BE:

- ☐ (A.) SPONSOR'S PLANNING DEFICIENCY
☒ (B.) CRITERIA DEFICIENCY
 1. DESIGN MANUAL
 2. GUIDE SPECS
 3. DEFINITIVE DRAWING
☐ (C.) DESIGN DEFICIENCY
☐ (D.) CONSTRUCTION DEFICIENCY
☐ (E.) COLLATERAL EQUIPMENT DEFICIENCY
☐ (F.) MAINTENANCE DEFICIENCY
☐ (G.) OTHER _____

2. THIS DEFICIENCY, IN THIS PROJECT, (HAS BEEN), ~~(SHOULD BE)~~ CORRECTED BY:

- ☐ (A.) APPROPRIATE FUNDS
☐ (B.) WARRANTY
☐ (C.) NO CORRECTION, (POSSIBLE) (NEEDED)
☒ (D.) OTHER Change Order

3. IN FUTURE PROJECTS, THIS DEFICIENCY ~~(HAS BEEN)~~ (SHOULD BE) AVOIDED BY:

- ☐ (A.) REVISION TO SPONSOR'S PLANNING DATA
☐ (B.) BETTER PLANS AND SPECS
☒ (C.) REVISION TO NAVFAC CRITERIA _____
☐ (D.) BETTER INSPECTION
☐ (E.) BETTER COORDINATION OF COLLATERAL EQUIPMENT
☐ (F.) BETTER PREVENTIVE MAINTENANCE
☐ (G.) NOT APPLICABLE

SPECIFIC RECOMMENDATIONS

FOR SUBJECT PROJECT: _____

FOR FUTURE PROJECTS: _____

(1)

POST OCCUPANCY EVALUATION OF

DEFICIENCY NO. 18: *Software doesn't appear to properly**convert differential pressure to steam flow rate. Original furnished 5 psid vs 3 psid design - software is 3 psid.*

1. THIS DEFICIENCY IS CONSIDERED TO BE:

- ☐ (A) SPONSOR'S PLANNING DEFICIENCY
- ☐ (B) CRITERIA DEFICIENCY
1. DESIGN MANUAL
2. GUIDE SPECS
3. DEFINITIVE DRAWING
- ☒ (C) DESIGN DEFICIENCY
- ☒ (D) CONSTRUCTION DEFICIENCY
- ☐ (E) COLLATERAL EQUIPMENT DEFICIENCY
- ☐ (F) MAINTENANCE DEFICIENCY
- ☐ (G) OTHER _____

2. THIS DEFICIENCY, IN THIS PROJECT, ~~(HAS BEEN)~~, (SHOULD BE) CORRECTED BY:

- ☐ (A) APPROPRIATE FUNDS
- ☐ (B) WARRANTY
- ☐ (C) NO CORRECTION (POSSIBLE) (NEEDED)
- ☒ (D) OTHER *Interaction between the ROICC and Contractor*

3. IN FUTURE PROJECTS, THIS DEFICIENCY ~~(HAS BEEN)~~ (SHOULD BE) AVOIDED BY:

- ☐ (A) REVISION TO SPONSOR'S PLANNING DATA
- ☒ (B) BETTER PLANS AND SPECS
- ☐ (C) REVISION TO NAVFAC CRITERIA _____
- ☐ (D) BETTER INSPECTION
- ☐ (E) BETTER COORDINATION OF COLLATERAL EQUIPMENT
- ☐ (F) BETTER PREVENTIVE MAINTENANCE
- ☐ (G) NOT APPLICABLE

SPECIFIC RECOMMENDATIONS

FOR SUBJECT PROJECT: _____

FOR FUTURE PROJECTS: *New G & S should adequately show real steam flow.* 1

POST OCCUPANCY EVALUATION OF

DEFICIENCY NO. 19 : Orifice plates sized for 5 psid vice spec'd 3 psid - Causes software misread of flow

1. THIS DEFICIENCY IS CONSIDERED TO BE:

- ☐ (A.) SPONSOR'S PLANNING DEFICIENCY
- ☐ (B.) CRITERIA DEFICIENCY
1. DESIGN MANUAL
2. GUIDE SPECS
3. DEFINITIVE DRAWING
- ☐ (C.) DESIGN DEFICIENCY
- ☐ (D.) CONSTRUCTION DEFICIENCY
- ☐ (E.) COLLATERAL EQUIPMENT DEFICIENCY
- ☐ (F.) MAINTENANCE DEFICIENCY
- ☐ (G.) OTHER _____

Combine with 18

2. THIS DEFICIENCY, IN THIS PROJECT, (HAS BEEN), (SHOULD BE) CORRECTED BY:

- ☐ (A.) APPROPRIATE FUNDS
- ☐ (B.) WARRANTY
- ☐ (C.) NO CORRECTION (POSSIBLE) (NEEDED)
- ☐ (D.) OTHER _____

3. IN FUTURE PROJECTS, THIS DEFICIENCY (HAS BEEN) (SHOULD BE) AVOIDED BY:

- ☐ (A.) REVISION TO SPONSOR'S PLANNING DATA
- ☐ (B.) BETTER PLANS AND SPECS
- ☐ (C.) REVISION TO NAVFAC CRITERIA _____
- ☐ (D.) BETTER INSPECTION
- ☐ (E.) BETTER COORDINATION OF COLLATERAL EQUIPMENT
- ☐ (F.) BETTER PREVENTIVE MAINTENANCE
- ☐ (G.) NOT APPLICABLE

SPECIFIC RECOMMENDATIONS

FOR SUBJECT PROJECT: _____

FOR FUTURE PROJECTS: _____

(1)

POST OCCUPANCY EVALUATION OF

DEFICIENCY NO. 20 : Steam flow rates not adequately addressed in P&S causing orifice plate mis-sizing

1. THIS DEFICIENCY IS CONSIDERED TO BE:

- ☐ (A.) SPONSOR'S PLANNING DEFICIENCY
- ☐ (B.) CRITERIA DEFICIENCY
1. DESIGN MANUAL
2. GUIDE SPECS
3. DEFINITIVE DRAWING

- ☒ (C.) DESIGN DEFICIENCY
- ☐ (D.) CONSTRUCTION DEFICIENCY
- ☐ (E.) COLLATERAL EQUIPMENT DEFICIENCY
- ☐ (F.) MAINTENANCE DEFICIENCY
- ☐ (G.) OTHER _____

2. THIS DEFICIENCY, IN THIS PROJECT, ^{IS BEING} ~~(HAS BEEN)~~, ~~(SHOULD BE)~~ CORRECTED BY:

- ☐ (A.) APPROPRIATE FUNDS
- ☐ (B.) WARRANTY
- ☐ (C.) NO CORRECTION (POSSIBLE) (NEEDED)
- ☒ (D.) OTHER Interaction between RCICC, Contractor, & EFD

3. IN FUTURE PROJECTS, THIS DEFICIENCY ~~(HAS BEEN)~~ (SHOULD BE) AVOIDED BY:

- ☐ (A.) REVISION TO SPONSOR'S PLANNING DATA
- ☒ (B.) BETTER PLANS AND SPECS
- ☐ (C.) REVISION TO NAVFAC CRITERIA _____
- ☐ (D.) BETTER INSPECTION
- ☐ (E.) BETTER COORDINATION OF COLLATERAL EQUIPMENT
- ☐ (F.) BETTER PREVENTIVE MAINTENANCE
- ☐ (G.) NOT APPLICABLE

SPECIFIC RECOMMENDATIONS

FOR SUBJECT PROJECT: _____

FOR FUTURE PROJECTS: Develop Guide Spec for fluid metering

①

POST OCCUPANCY EVALUATION OF

DEFICIENCY NO. 21: Provide direct control of heating/cooling coils to unload compressors vice cycling AHU's.

1. THIS DEFICIENCY IS CONSIDERED TO BE:

- ☐ (A) SPONSOR'S PLANNING DEFICIENCY
- ☒ (B) CRITERIA DEFICIENCY
1. DESIGN MANUAL
2. GUIDE SPECS
3. DEFINITIVE DRAWING
- ☐ (C) DESIGN DEFICIENCY
- ☐ (D) CONSTRUCTION DEFICIENCY
- ☐ (E) COLLATERAL EQUIPMENT DEFICIENCY
- ☐ (F) MAINTENANCE DEFICIENCY
- ☐ (G) OTHER _____

2. THIS DEFICIENCY, IN THIS PROJECT, (~~HAS BEEN~~), (SHOULD BE) CORRECTED BY:

- ☐ (A) APPROPRIATE FUNDS
- ☐ (B) WARRANTY
- ☐ (C) NO CORRECTION (POSSIBLE) (NEEDED)
- ☒ (D) OTHER Elim. duty cycling.

3. IN FUTURE PROJECTS, THIS DEFICIENCY (HAS BEEN) (SHOULD BE) AVOIDED BY:

- ☐ (A) REVISION TO SPONSOR'S PLANNING DATA
- ☐ (B) BETTER PLANS AND SPECS
- ☒ (C) REVISION TO NAVFAC CRITERIA _____
- ☐ (D) BETTER INSPECTION
- ☐ (E) BETTER COORDINATION OF COLLATERAL EQUIPMENT
- ☐ (F) BETTER PREVENTIVE MAINTENANCE
- ☐ (G) NOT APPLICABLE

SPECIFIC RECOMMENDATIONS

FOR SUBJECT PROJECT: _____

FOR FUTURE PROJECTS: _____

(1)

POST OCCUPANCY EVALUATION OF

DEFICIENCY NO. 22 : (AHU) Air Handling Units should not cycle -
compressors or chillers ~~rather~~ on own controls better -

1. THIS DEFICIENCY IS CONSIDERED TO BE:

- ☐ (A) SPONSOR'S PLANNING DEFICIENCY
- ☐ (B) CRITERIA DEFICIENCY
1. DESIGN MANUAL
2. GUIDE SPECS
3. DEFINITIVE DRAWING
- ☐ (C) DESIGN DEFICIENCY
- ☐ (D) CONSTRUCTION DEFICIENCY
- ☐ (E) COLLATERAL EQUIPMENT DEFICIENCY
- ☐ (F) MAINTENANCE DEFICIENCY
- ☐ (G) OTHER _____

*Combine with
21.*

2. THIS DEFICIENCY, IN THIS PROJECT, (HAS BEEN), (SHOULD BE) CORRECTED BY:

- ☐ (A) APPROPRIATE FUNDS
- ☐ (B) WARRANTY
- ☐ (C) NO CORRECTION (POSSIBLE) (NEEDED)
- ☐ (D) OTHER _____

3. IN FUTURE PROJECTS, THIS DEFICIENCY (HAS BEEN) (SHOULD BE) AVOIDED BY:

- ☐ (A) REVISION TO SPONSOR'S PLANNING DATA
- ☐ (B) BETTER PLANS AND SPECS
- ☐ (C) REVISION TO NAVFAC CRITERIA _____
- ☐ (D) BETTER INSPECTION
- ☐ (E) BETTER COORDINATION OF COLLATERAL EQUIPMENT
- ☐ (F) BETTER PREVENTIVE MAINTENANCE
- ☐ (G) NOT APPLICABLE

SPECIFIC RECOMMENDATIONS

FOR SUBJECT PROJECT: _____

FOR FUTURE PROJECTS: _____

1

POST OCCUPANCY EVALUATION OF

DEFICIENCY NO. 23 : Zone Controls should be both Temperature & Time - Not either one alone

1. THIS DEFICIENCY IS CONSIDERED TO BE:

- ☐ (A) SPONSOR'S PLANNING DEFICIENCY
- ☒ (B) CRITERIA DEFICIENCY
1. DESIGN MANUAL
2. GUIDE SPECS
3. DEFINITIVE DRAWING
- ☐ (C) DESIGN DEFICIENCY
- ☐ (D) CONSTRUCTION DEFICIENCY
- ☐ (E) COLLATERAL EQUIPMENT DEFICIENCY
- ☐ (F) MAINTENANCE DEFICIENCY
- ☐ (G) OTHER _____

2. THIS DEFICIENCY, IN THIS PROJECT, (~~WAS NOT~~), (SHOULD BE) CORRECTED BY:

- ☐ (A) APPROPRIATE FUNDS
- ☐ (B) WARRANTY
- ☒ (C) NO CORRECTION (POSSIBLE) (~~WAS NOT~~)
- ☐ (D) OTHER _____

3. IN FUTURE PROJECTS, THIS DEFICIENCY (HAS BEEN) (SHOULD BE) AVOIDED BY:

- ☐ (A) REVISION TO SPONSOR'S PLANNING DATA
- ☐ (B) BETTER PLANS AND SPECS
- ☒ (C) REVISION TO NAVFAC CRITERIA _____
- ☐ (D) BETTER INSPECTION
- ☐ (E) BETTER COORDINATION OF COLLATERAL EQUIPMENT
- ☐ (F) BETTER PREVENTIVE MAINTENANCE
- ☐ (G) NOT APPLICABLE

SPECIFIC RECOMMENDATIONS

FOR SUBJECT PROJECT: _____

FOR FUTURE PROJECTS: _____

POST OCCUPANCY EVALUATION OF

DEFICIENCY NO. 24 : Handling of asbestos insulation on steam piping not identified

1. THIS DEFICIENCY IS CONSIDERED TO BE:

- ☐ (A) SPONSOR'S PLANNING DEFICIENCY
☐ (B) CRITERIA DEFICIENCY
 1. DESIGN MANUAL
 2. GUIDE SPECS
 3. DEFINITIVE DRAWING
☒ (C) DESIGN DEFICIENCY
☐ (D) CONSTRUCTION DEFICIENCY
☐ (E) COLLATERAL EQUIPMENT DEFICIENCY
☐ (F) MAINTENANCE DEFICIENCY
☐ (G) OTHER _____

2. THIS DEFICIENCY, IN THIS PROJECT, (HAS BEEN), ~~(SHOULD BE)~~ CORRECTED BY:

- ☐ (A) APPROPRIATE FUNDS
☐ (B) WARRANTY
☐ (C) NO CORRECTION (POSSIBLE) (NEEDED)
☐ (D) OTHER _____

3. IN FUTURE PROJECTS, THIS DEFICIENCY (HAS BEEN) (SHOULD BE) AVOIDED BY:

- ☐ (A) REVISION TO SPONSOR'S PLANNING DATA
☒ (B) BETTER PLANS AND SPECS
☐ (C) REVISION TO NAVFAC CRITERIA _____
☐ (D) BETTER INSPECTION
☐ (E) BETTER COORDINATION OF COLLATERAL EQUIPMENT
☐ (F) BETTER PREVENTIVE MAINTENANCE
☐ (G) NOT APPLICABLE

SPECIFIC RECOMMENDATIONS

FOR SUBJECT PROJECT: _____

FOR FUTURE PROJECTS: Nature of asbestos hazard makes mandating that specification cover correct handling (1)

POST OCCUPANCY EVALUATION OF

DEFICIENCY NO. 24 : *Kilovolt meters inoperative due to too large current transformers*

1. THIS DEFICIENCY IS CONSIDERED TO BE:

- ☐ (A) SPONSOR'S PLANNING DEFICIENCY
- ☐ (B) CRITERIA DEFICIENCY
1. DESIGN MANUAL
2. GUIDE SPECS
3. DEFINITIVE DRAWING
- ☐ (C) DESIGN DEFICIENCY
- ☐ (D) CONSTRUCTION DEFICIENCY
- ☐ (E) COLLATERAL EQUIPMENT DEFICIENCY
- ☐ (F) MAINTENANCE DEFICIENCY
- ☐ (G) OTHER _____

2. THIS DEFICIENCY, IN THIS PROJECT, (HAS BEEN), (SHOULD BE) CORRECTED BY:

- ☐ (A) APPROPRIATE FUNDS
- ☐ (B) WARRANTY
- ☐ (C) NO CORRECTION (POSSIBLE) (NEEDED)
- ☐ (D) OTHER _____

3. IN FUTURE PROJECTS, THIS DEFICIENCY (HAS BEEN) (SHOULD BE) AVOIDED BY:

- ☐ (A) REVISION TO SPONSOR'S PLANNING DATA
- ☐ (B) BETTER PLANS AND SPECS
- ☐ (C) REVISION TO NAVFAC CRITERIA _____
- ☐ (D) BETTER INSPECTION
- ☐ (E) BETTER COORDINATION OF COLLATERAL EQUIPMENT
- ☐ (F) BETTER PREVENTIVE MAINTENANCE
- ☐ (G) NOT APPLICABLE

SPECIFIC RECOMMENDATIONS

FOR SUBJECT PROJECT: _____

FOR FUTURE PROJECTS: _____

(1)

POST OCCUPANCY EVALUATION OF

DEFICIENCY NO. 25: Summer-Winter Changeover software
inadequate.

1. THIS DEFICIENCY IS CONSIDERED TO BE:

- ☐ (A) SPONSOR'S PLANNING DEFICIENCY
- ☒ (B) CRITERIA DEFICIENCY
1. DESIGN MANUAL
2. GUIDE SPECS
3. DEFINITIVE DRAWING
- ☐ (C) DESIGN DEFICIENCY
- ☐ (D) CONSTRUCTION DEFICIENCY
- ☐ (E) COLLATERAL EQUIPMENT DEFICIENCY
- ☐ (F) MAINTENANCE DEFICIENCY
- ☐ (G) OTHER _____

2. THIS DEFICIENCY, IN THIS PROJECT, ~~(HAS BEEN)~~, (SHOULD BE) CORRECTED BY:

- ☐ (A) APPROPRIATE FUNDS
- ☐ (B) WARRANTY
- ☒ (C) NO CORRECTION (POSSIBLE) ~~(HAS BEEN)~~ This Contract
- ☐ (D) OTHER _____

3. IN FUTURE PROJECTS, THIS DEFICIENCY (HAS BEEN) (SHOULD BE) AVOIDED BY:

- ☐ (A) REVISION TO SPONSOR'S PLANNING DATA
- ☐ (B) BETTER PLANS AND SPECS
- ☒ (C) REVISION TO NAVFAC CRITERIA _____
- ☐ (D) BETTER INSPECTION
- ☐ (E) BETTER COORDINATION OF COLLATERAL EQUIPMENT
- ☐ (F) BETTER PREVENTIVE MAINTENANCE
- ☐ (G) NOT APPLICABLE

SPECIFIC RECOMMENDATIONS

FOR SUBJECT PROJECT: _____

FOR FUTURE PROJECTS: Assure that future requirements are specified (1)
to have returned to the contractor.

POST OCCUPANCY EVALUATION OF

DEFICIENCY NO. 26 : Contention resolution of competing software not adequately addressed

1. THIS DEFICIENCY IS CONSIDERED TO BE:

- ☐ (A) SPONSOR'S PLANNING DEFICIENCY
- ☒ (B) CRITERIA DEFICIENCY
1. DESIGN MANUAL
2. GUIDE SPECS
3. DEFINITIVE DRAWING

- ☐ (C) DESIGN DEFICIENCY
- ☐ (D) CONSTRUCTION DEFICIENCY
- ☐ (E) COLLATERAL EQUIPMENT DEFICIENCY
- ☐ (F) MAINTENANCE DEFICIENCY
- ☐ (G) OTHER _____

2. THIS DEFICIENCY, IN THIS PROJECT, (HAS BEEN), (SHOULD BE) CORRECTED BY:

- ☐ (A) APPROPRIATE FUNDS
- ☐ (B) WARRANTY
- ☒ (C) NO CORRECTION (POSSIBLE) (NEEDED)
- ☐ (D) OTHER _____

3. IN FUTURE PROJECTS, THIS DEFICIENCY ~~(HAS BEEN)~~ (SHOULD BE) AVOIDED BY:

- ☐ (A) REVISION TO SPONSOR'S PLANNING DATA
- ☐ (B) BETTER PLANS AND SPECS
- ☒ (C) REVISION TO NAVFAC CRITERIA _____
- ☐ (D) BETTER INSPECTION
- ☐ (E) BETTER COORDINATION OF COLLATERAL EQUIPMENT
- ☐ (F) BETTER PREVENTIVE MAINTENANCE
- ☐ (G) NOT APPLICABLE

SPECIFIC RECOMMENDATIONS

FOR SUBJECT PROJECT: _____

FOR FUTURE PROJECTS: Software provided to priority software procedures.

(1)

9 September 1983

POST OCCUPANCY EVALUATION

1. Background: The Norfolk Naval Shipyard (NNSY) Energy Monitoring and Controls System (EMCS) was accepted by the Navy on 3 March 1983. The system, designed by the A&E firm, Newcomb and Boyd, under the 1978 Tri Service Guide Specification, includes 50 Field Interface Devices (FID's) and has approximately 700 points connected. The central computer system hardware is mainly Digital Equipment Corporation (DEC) equipment built around two model PDP 11/34 central processing units with 256 kilobytes of memory each. Various peripherals include four 10.4 megabyte disk drives, a 1/2 inch magnetic tape drive, a black and white CRT, an alarm printer, and a report printer. The system also includes an ISC Intecolor 8001 Color Graphics display terminal with light pen input. The Contractor, HSQ Technology, provided Staefa Controls EMS 1.0 software. The entire EMCS cost approximately \$1.2 million.
2. On August 9, 1983, a team of engineers and technicians from NAVFAC Headquarters, LANTDIV, and Norfolk Naval Shipyard (NNSY) assembled to perform a Post Occupancy Evaluation (POE) of the NNSY Energy Monitoring and Control System (EMCS). The POE was scheduled for three days, 9 August 1983 to 11 August 1983. A list of the POE participants is enclosed.
3. The POE began at 0900, 9 August 1983. During the initial meeting, Mr. John Knapp, the POE Team Leader, explained that the purpose of the POE was to analyze, in much depth, every aspect of the EMCS. This was to include system design, construction, maintenance, and contract administration. After the initial meeting, the team went to the EMCS control room where a brief system description was given by Mr. Bill Williams, the EMCS System Engineer. This lasted from 1030 to 1200. Mr. Williams had prepared an extensive list of what he felt were EMCS problem areas. The remainder of the first day was spent in a roundtable discussion of the items on Mr. Williams' list.
4. On the second day of the POE, the team met at 0800 and continued discussions based on Mr. Williams' list. At 0900, the team split into two groups to conduct a field survey. The team regrouped at 1230 to discuss their findings. The remainder of the second day was spent discussing and amending the standard POE forms. Upon completion of the forms the POE was officially called to an end.
5. Mr. Knapp showed the POE team the standard POE form during the first meeting. These forms were to be given to each participant to be used throughout the POE, wherever the participant felt it appropriate. At the end of POE, each used form was to be discussed by the entire team. From these discussions, a final set of forms was to be assembled.

(2)

6. Overall, the discussions that took place during the POE were quite good. Each topic was thoroughly analyzed and all aspects were covered in detail. Numerous excellent ideas and observations were brought out. Many of the POE team members contributed.
7. The NNSY EMCS project includes an Electrical Supervisory System (ESS) which interfaces with the existing Visicode system and Substations 6 and 11. The ESS monitors and controls certain breakers and switchgear. Although the ESS was something of an experiment, it has become a very useful tool for personnel of the NNSY. The existing Visicode is incorrigibly outdated - the manufacturer stopped supporting it years ago; it cannot be expanded; parts are not available; and expertise with the system is dwindling. When breakers were added to the NNSY distribution system, the only available method of control was accomplished by sending a man to the substation. The ESS provides NNSY with remote monitoring and control capability. Until the Visicode can be replaced, the ESS credibly fills this void.
8. Other items that were not included in the POE sheets are listed below:
 - a. The basic design and energy saving strategies are done by the designer (A&E). The Contractor is supposed to do his own building survey and the detailed design. This was a point of contention on the NNSY EMCS. On future projects, the contract wording should better illuminate these requirements. Also, it should be made clear that drawings, schematics, etc. that the Contractor may need or desire will not be available.
 - b. Obtaining telephone lines in a timely manner seems to be a problem on most EMCS projects and NNSY was no exception. Much better coordination and identification of responsibilities is needed. The A&E should be tasked with determining, roughly, the telephone line needs of a project. Project management should get written confirmation of telephone line availability from the base. The ROICC should be made aware of the telephone requirements early in the project so proper actions can be initiated.
 - c. Contractor Quality Control (CQC) was not effective on the NNSY EMCS and its usefulness on EMCS contracts in general was discussed. Although there were strong arguments both for and against, the question of whether to strengthen, amend, or delete CQC was left unresolved.
 - d. The 30 day acceptance test, which is a part of virtually every EMCS, was waived on this contract. This was mainly because of difficulty in working with the Contractor. This was discussed only very briefly at the POE.

- e. An experience clause requires a prospective bidder to have successfully installed a system similar to one under consideration in order for his bid to be accepted. Although the NNSY EMCS did not have such a clause, this POE may have been a good place to discuss its possible future use for EMCS projects.
 - f. The subject of Contractor provided training never came up during the POE. Training is being seriously underemphasized at present.
 - g. The EMCS central processing unit (CPU) is sometimes slow to respond to operator requests for data, particularly when graphics are in use. This can be directly attributed to the amount of main memory accessible to the CPU. Although there are 256 kilobytes of memory within the CPU, because of the way the computer's operating system (OS) is configured, only 128 kilobytes are being used. The OS can be reconfigured to recognize the entire 256 kilobytes, but at present, NNSY personnel do not have the expertise to do this.
9. Information from this POE may be of immediate use to an A&E designing an EMCS. Below is a list of items that, in addition to those already listed, helps illustrate that type of information. The items listed have been synopsized from the POE forms.
- a. Include sufficient detail in piping plans and specifications for special requirements of instrument piping.
 - b. A potential freeze-up problem exists where steam line control piping is exposed to the weather without insulation. Also, a safety problem exists where repair, maintenance, or installation of valves, instrumentation, etc. takes place on steam lines and insulation is not restored. Insure insulation specification covers these items.
 - c. A major problem exists in requiring the Contractor to keep sufficient spare parts and maintenance staff on-site. Specifications should require the submittal for approval of a schedule of spare parts and maintenance staffing. Also, maintenance response time requirements need tighter specifications.
 - d. Do not use aquastats on steam piping to provide pressure reducing valve (PRV) status. The maximum upper temperature on aquastats is too low for this application. Flow or pressure sensors should be chosen.
 - e. The A&E must collect accurate steam flow data to properly size orifice plates. Improperly sized orifice plates cause waste and delays. They may cause damage to piping in the extreme case.

- f. When controlling an Air Handling Unit (AHU), provide control of heating/ cooling coils instead of the fan.
- g. Provide for handling of asbestos insulation in specifications.
- h. Specify, in greater detail, how summer/winter software changeover is to be accomplished.

Rodney D. Rienarth

Listed below are participants in the NNSY EMCS POE:

* John Knapp	NAVFAC 04T - Mr. Knapp is the head of the NAVFAC Technology Branch and was the Team Leader for the POE
* Rodney Rienenrth	LANTDIV 404C - NNSY EMCS EIC
* Casto DeBiasi	NAVFAC Hdqtrs - Mechanical Systems (EMCS)
* Robert Bersson	NAVFAC Hdqtrs - Inspection & Tests (EMCS)
* Angelo Tjoumas	NAVFAC Hdqtrs - Project Management
* Tom Turlip	LANTDIV 0522 - Mr. Turlip was the AROICC for the NNSY EMCS
* Jim Richmond	LANTDIV 111 - Mr. Richmond was 0522 for the NNSY EMCS before transferring to the Utilities Division
* Joe Watson	LANTDIV 403 - Mr. Watson is the head of the LANTDIV Mechanical Branch
* Jerry Imrich	LANTDIV 403
* Bill Rust	LANTDIV 102
* Bill Morgan	LANTDIV 111
* Cdr. John Perry	NNSY ROICC - Cdr. Perry is the Resident Officer in Charge of Construction at NNSY
* Fred Bowen	NNSY ROICC Inspector - Mr. Bowen was the Construction Inspector for the NNSY EMCS
* Dwight Smith	NNSY Public Works - Mr. Smith is the Energy Program Manager at NNSY
* Bill Williams	NNSY EMCS - Mr. Williams is the EMCS System Engineer
* Buc Milbee	NNSY Utilities - Mr. Milbee is the NNSY Superintendent of Utilities

Energy Monitoring and Control System (EMCS)

I. Concerns

A. An effective energy conservation program is difficult to implement at the shipyard. A need exists for higher authority to provide additional policy and guidance on the "Navy's Energy Plan".

B. Corporate knowledge is lacking on how to best utilize EMCS. A need exists for LANTDIV to provide:

OPB problem

1. Technical support and analytical tools for implementing the data base.

2. Methods for documenting actual energy savings.

C. The present EMCS installation does not appear to pay for itself within the allotted time period. A need exists for the A/E to analyze actual energy savings versus predicted savings and make recommendations to improve the situation. For example, since no software application program exists for boiler management, the shipyard is unable to improve the boiler efficiency in Building 174 using EMCS. Newcomb and Boyd predicted a 2% increase in efficiency which correlates to 216,294 gallons of fuel oil or \$114,636.00 per year.

D. Staffing is very difficult at the shipyard, since no guidelines exist for filling EMCS billets. A need exists for OPM to develop EMCS position/job descriptions and corresponding standards which can be used by the local Industrial Relations Office.

Fill Form
Army

II. Design Considerations

A. Criteria for energy savings should have been based upon a closed system environment (ie - zone) versus individual equipment savings. Something went wrong between A/E survey and I/O summary selection.

B. When the equipment was selected within the zone, automatic control should have been based upon temperature and time as opposed to time only. Temperature control has the following advantages:

1. Provides constant temperature within building, minimum energy usage, and reduces personnel complaints.

2. Allows the fan on air handling units to run while the compressors are secured, providing continuous air circulation.

3. Allows direct control over heating and cooling coils, thus enabling better control over the source of energy.

C. Load shedding at the shipyard will not significantly save energy using the present EMCS installation.

1. Electrical equipment capable of being deenergized is minor with EMCS.

Energy Monitoring and Control System (EMCS)

2. Muse generators are better way of reducing the electrical demand during peak periods.

D. Steam flow measurements are not accurate.

1. Steam flowrate was not adequately addressed in the design drawings causing errors in the orifice plate sizing.

2. Orifice plate sizing was based upon a maximum pressure drop of five (5) psid, instead of 3 psid as required.

3. Software program does not appear to properly convert differential pressure to steam flowrate.

E. Aquastats on downstream steam piping does not provide proper indication for the pressure regulating valves (PRV's). The aquastat range is insufficient to give timely PRV status which is necessary for the automatic multiple event (ie - Aquastats are set at 200°F and steam pipe temperatures are approximately 325°F).

III. Specifications

A. Specifications were too general, and government was unable to enforce requirements. Software application programs have not been provided for; boiler management, chiller profile, dynamic energy display, and damper/enthalpy control program.

B. The contractor performed the 30 day final operational acceptance test without approval from the government. EMCS has never been fully tested to ensure that the system is functioning properly in accordance with all requirements of specification by appropriate government representatives. (ie - NAVFAC, LANTDIV, and ROICC).

C. Operations and maintenance portion of specification are not being enforced. One contractor representative provides technical guidance and assistance to Shop 03 personnel. The contractor is responsible for warranty items, however the response has been poor due to a lack of sufficient spare parts on site.

IV. Documentation

A. Shipyard has not received as-built drawings. Drawings are necessary to troubleshoot the system.

B. Shipyard does not have multiplexer panel (ie - MTU) document to show signal values or memory mapping. Above information is required to troubleshoot and expand system in the future.

V. Training

A. Shipyard personnel have not received Phase III training, however it is tentatively scheduled for 22-26 August 1983.

(3)

Energy Monitoring and Control System (EMCS)VI. Recommendations

A. Change order needs to be implemented as soon as possible using the following priorities as a guideline.

1. Modify O&M agreement requiring HSQ improve their maintenance service since spare parts will not be received in near future.

2. Modify the computer hardware in the master control room, thus enlarging primary memory space and expanding EMCS capability.

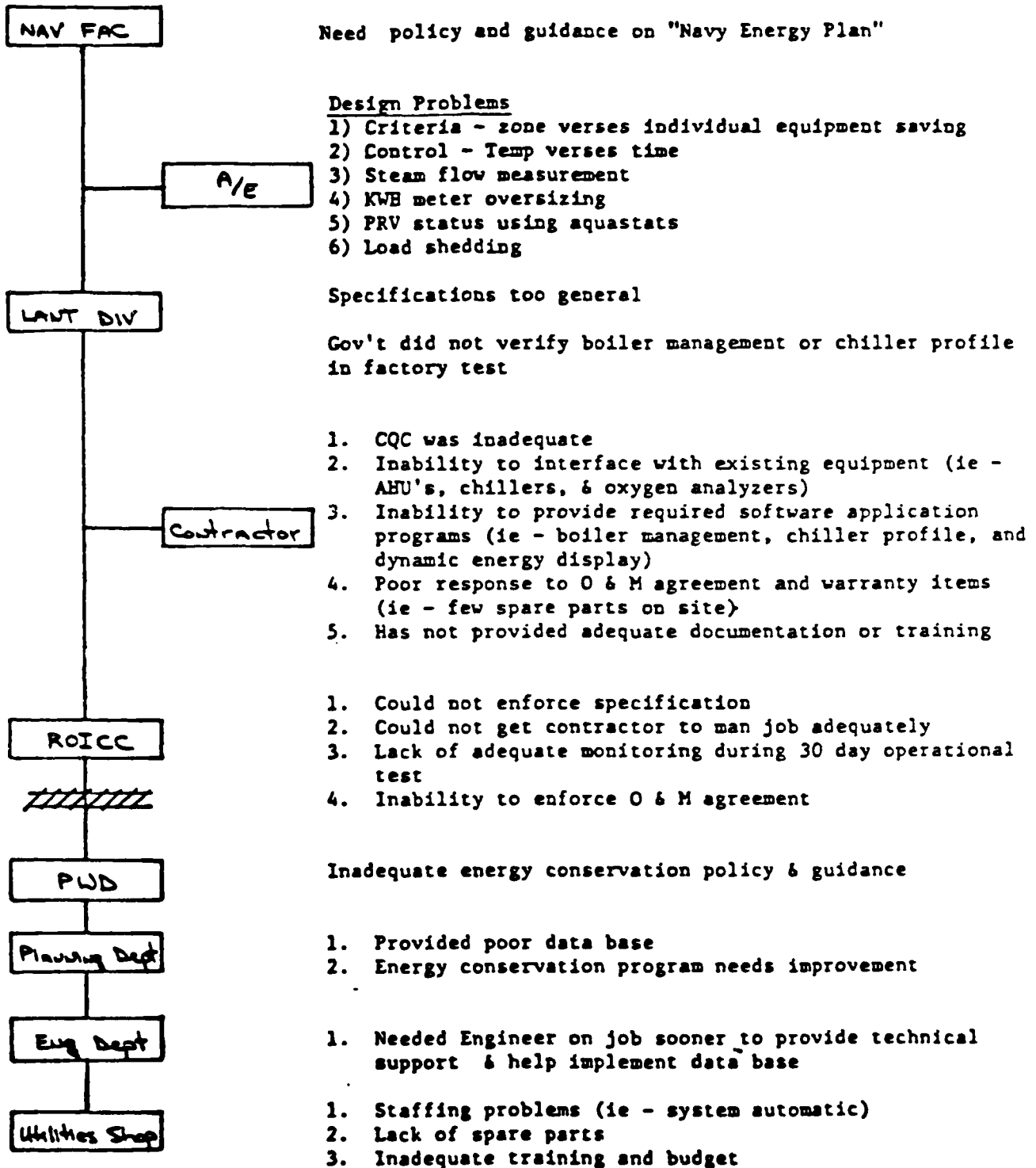
3. Implement new RSX-11M operating system and train shipyard personnel.

4. Develop software application programs for boiler management and chiller profile.

5. Install EMCS field hardware between equipment and master control room, implement data base, and operationally test system.

B. The existing system needs updating to incorporate new equipment and building alternations over last 5 years. This will require additional EMCS controls on HVAC equipment in selected buildings. Installation expenses would be minimal when compared to the significant energy and cost savings.

C. EMCS requirements for electric and steam metering need to be accessed, since metering would be used to document energy savings.



DEMU (Mr. White, 3237):27Jul83/act/1331:

Staff Visit to Langley AFB, 5-22 Jul 83

Langley AFB/DE

1. The following findings and recommendations have been complied with to help in the organization and operation of the system management section including the operations section (467) and E & C Shop (468 & 469). In an effort to help in the implementation of the recommendations they have been subdivided.

System Management

a. Finding: System manager is not spending adequate time in the EMCS computer room getting familiar with EMCS operation.

Recommendation: The system manager should spend more of his time performing and learning routine procedures including data base update, disk backup, reassigning peripherals, system generation, graphic generation, prom burning, and FID reset/loading/programming. This is the bread and butter of the EMCS. Only with an intimate knowledge of the procedures can the EMCS function in a cost effective and useful manner. In addition, the system manager will be responsible for providing necessary training to the operator. Approximately four hours per day should be spent in the computer room until routine procedures can be performed without using reference material.

b. Finding: A review of the operating instructions (OIs) was made to determine if the operators had adequate instructions to perform their duties. Overall operating instructions were adequate with the exception of special instructions. There was no order to the special instructions or in some cases they were not explicit enough thus allowing for operator error.

Recommendation: System manager should review the existing OIs to determine if they are applicable. In addition, the special instruction should be reviewed and indexed in an orderly manner. See attachment one for an example of how the special instructions may look. These instructions should be explicit, i.e. when to contact the BCE? What quarters are considered an emergency for no A/C after normal duty hours, etc. These special instructions should be reviewed quarterly by the system manager to determine if any of the instructions should be modified or revoked. Each operator should check the OIs and initial new special instructions when they are inserted in the binder.

c. Finding: The service call specialist could not locate the list to determine which shop (mech or E & C) would respond to "no heat/cooling" first. At present, word of mouth is the only means of determining what shop will respond first.

Recommendation: The mechanical superintendent and system manager should review the existing list quarterly to determine if any buildings should be changed for first response. A list was given to service call during visit.

d. Finding: Dialogue between the system manager and shop superintendents is limited.

Recommendation: The system manager should make a special effort to talk to the mechanical superintendent and E & C shop foreman at the beginning of the work day. Although Mr Gibson and Mr Howard talk daily, the system manager should be in the loop and be aware of any special problem that the shops might be working that day.

e. Finding: The system manager should get more involved in O & M design projects and designs of new facilities. It is the responsibility of the system manager to insure the right EMCS points are incorporated in the design. All designs that have to do with controls, HVAC, fire, security or energy in general, should be signed off by the system manager.

Recommendation: It is not only the responsibility of the system manager but also the Chief of Design to insure all designs are reviewed by the system manager.

Operations

f. Finding: In a number of buildings many application programs have been disabled including duty cycling, optimum start/stop, and demand limit. In addition, a review of the documentation has shown it is not up to date

Recommendation: The system manager should enable these programs as soon as possible. Prior to enabling these programs, the system manager should check the point parameters and documentation to insure the limits are reasonable for a particular building. For example, comfort limits should be set at 68° - 75° in lieu of 64° - 79°. This would permit duty cycling only in those temperature ranges. The duty cycle for bldg 602 should be five minutes out of 45 with a max off time of seven minutes, a min off time of five minutes and min on time of three minutes. Bldg 681 may be duty cycled ten minutes out of 60 with a max off time of 12 minutes, a min off time of five and a min on time of three minutes. Each point should be addressed separately taking into account the mass of the building, type of point, and location of the point in the building. Optimum start/stop program should also be reevaluated, especially looking at the target temperature for the particular point. A review of the optimum start/stop summary should be made daily to determine if the desired target is met, if not, an adjustment may be in order. The system manager should do one building at a time until each building has been checked out and completed.

g. Finding: In some instances, standby personnel are not responding to the operator after duty. There have been many occasions that the standby person could not be reached or would not respond when contacted.

Recommendation: A new procedure should be implemented to put the responsibility of standby on the shoulders of the shop foreman. The shop foreman and superintendent would maintain an updated standby roster. If the operator cannot reach the standby person or the standby person does not respond, the call would be turned over to the shop foreman or superintendent (if foreman cannot be reached) who would then be responsible to find someone to take the call or take care of it himself. This would insure shop personnel are aware of the importance of standby duty and would afford the shop foreman of disciplinary problems.

h. Finding: The controller function performed by the EMCS operators for the E & C shop is not working satisfactorily. The problems seem to stem around the fact that five operators are actively working it. By the time one operator gets the procedure down he changes shift and a new operator comes on board. After talking with Mr Howard and the operators, I feel this function should be performed in the E & C shop.

Recommendation: The controller function should be performed in the E & C shop. This would afford the operators more time to monitor and control the EMCS connected buildings (make schedule changes, trends and logs). Recommend the system manager request a waiver in writing to HQ TAC/DEM. In addition the operator could use this time to learn how to reprogram the FIDs(560s) and MUXEX(540s).

i. Finding: Lack of a head operator or system manager's assistant. This person would offer guidance to other operators, would be able to troubleshoot the EMCS including central and field software and hardware.

Recommendation: Use Harris' position and hire a lead operator that could assist the system manager in the complete operation and maintenance of the EMCS.

j. Finding: The operators are not familiar with the HVAC equipment and the location of the associated EMCS sensors and controllers.

Recommendation: An exchange program should be set up between the E & C shop and operators. This would allow the operator to become familiar with field equipment and also allow the mechanics to become familiar with the operations section.

k. Finding: Standard reports are not being used by the operator to determine the condition of the EMCS. For example an alarm report should be run at the beginning of each shift, application software report should be run daily, all points log run daily, run time reports should be used to calculate savings, and trend logs should be run as required to help solve a particular problem.

Recommendation: The system manager should utilize the EMCS to its full potential to insure enviromental conditions are acceptable and major problem areas are brought to the attention of the Ops Chief and BCE. Too many alarms are ignored because the alarm limits are unrealistic, connected equipment is not operating correctly or the operator does not acknowledge that the alarm is critical enough for his intervention.

l. Finding: Operators tend to loose knowledge of recurring problems by changing shifts every two weeks.

Recommendation: Extend shifts to four to six weeks, thus allowing adequate time for operator to get familiar with his shift.

m. Finding: Observation of the operators over the past two weeks show that additional training may be necessary. For example, the operator should be able to analyze connected HVAC systems, make basic adjustments to the data parameters and limited programming of the central and field equipment.

Recommendation: System manager should evaluate each and every operator to determine what level he is at in understanding the overall operation of the EMCS section, what duties they actually perform and what additional training they may need. Attachment two, Training Program for Utility Systems Operator, should be used as a guide by the system manager to insure all operators are performing duties that are associated with their grade. As mentioned earlier (para 1.a) the system manager should be familiar with all aspects of the operation of the EMCS since he will be responsible for training the operators. Only through constant training will the operators use the system to its maximum.

E & C Shop

n. Finding: The E & C shop is performing informal OJT by rotating military personnel with the various civilians in the shop. This concept has proven very beneficial in gaining experience in all areas of control and electronics. In addition, the electronics mechanics have been with Honeywell, as time permits, to learn how to troubleshoot the 560s and 540s.

Recommendation: Continue with the OJT as it is being done at present. In addition, formal classroom training should be planned for the shop. This would entail standing down the shop for approximately one hour a week and discuss various control system repair or maintenance. The electronics mechanic should continue to obtain as much OJT from Honeywell as possible.

o. Finding: Key operated Local-Off-Computer (LOC) switches have not been installed. Numerous utility dollars have been wasted by letting the occupant turn the existing switch to local.

Recommendation: Fund a project to install key operated switches at the earliest possible time. Realizing money is short, this project would have an immediate payback.

p. Finding: A meeting was held with the deputy ops chief, chief of production control, system manager and E & C shop supervisor, mechanical and electrical superintendent and respective shop foremen to discuss the areas of responsibility between the E & C shop and other shops. We discussed the upcoming TAC regulation on EMCS which defined the area of responsibilities. Overall there seems to be no problems regarding who responds first to our no heat/no cooling service call providing the list is kept updated at service call. Two areas that need to be addressed is cathodic protection and maintenance of HVAC air compressors. Cathodic protection is being performed in the E & C shop at present in lieu of the interior electric shop. In addition, maintenance of HVAC air compressors should be the responsibility of the E & C shop.

Recommendation: Cathodic protection should be gradually moved back into the interior electric shop only after adequate training has been obtained. In addition, maintenance of the HVAC air compressors should be transferred to the E & C shop.

q. Finding: A trip was made to base supply with SSgt Young to determine why a piece of equipment was substituted for TA-487 equipment. We started out in allowances and authorizations and were sent to stock control; from there we were sent to file maintenance and then to inspection. Inspection indicated it must have been research who said it wasn't them. From that point we went to customer liaison who ran an inquiry for us. He could not provide an adequate explanation of how we received the equipment. I am convinced that no one person knows how base supply works and if that person exists, he is lost forever in the red tape and inherit maze that has been created.

Recommendation: None. It is hopeless.

r. Finding: A review of the E & C shop was made to determine if they were performing assigned duties as outlined in AFR 85-10. Discussions were held with the shop supervisor and mechanics.

Recommendation: The E & C shop is performing duties as stated in AFR 85-10. The supervisor and mechanics have a "can do" attitude and have made great strides in correcting control related problems at Langley. Keep up the good work.

2. A review of the EMCS was made to determine where we stand in completing the project with Honeywell. Since the end of the 30-day acceptance test Honeywell has replaced the central softwares twice with monthly updates in Feb, Mar, Apr and May. The time boards, CPU boards, EIA boards and memory boards have been replaced in the FIDs. In a number of the Muxs, boards were replaced. In addition FID software is being updated. To insure

Honeywell fulfills their contractual obligation, I recommend a letter be written to contracts requesting Honeywell perform an endurance test prior the final acceptance of the project.

3. Questions concerning these findings and recommendations may be addressed to Tom White, HQ TAC/DEMU, extension 3237.

THOMAS E. WHITE, GS-13
Electronics Engineer

Atch

SPECIAL INSTRUCTION

NUMBER _____

DATE _____

SUBJECT:

DISCUSSION:

**SPECIAL
INSTRUCTIONS**

INDEX

SUBJECT

OPERATOR INITIALS/DATE

Attachment 1

(4)

TRAINING PROGRAM FOR UTILITY SYSTEMS OPERATORPHASE I - ORIENTATION AND FAMILIARIZATIONA. ORIENTATION OF EMCS SECTION:

1. Section Policy
2. Work Assignments
3. Shift Assignments and Operation Procedures

B. SERVICE CALL FUNCTIONS:

1. Duties of Service Call Specialist

C. FAMILIARIZATION OF EMCS FUNCTIONS:

1. Philosophy
2. Overview of EMCS
3. Introduction to EMCS equipment function and operation of remote sensors, at individual buildings and central computer area.
4. Introduction to operation Electrical Demand Determent System.

D. PERFORMANCE OF BASIC OPERATION ON EMCS CENTRAL EQUIPMENT:

1. Basic operation of black and white CRT terminals
2. Basic operation of color graphic CRT terminal
3. Basic operation of on-line printer/terminal and alarm report printer.
4. Basic operation of Electrical Demand Deferment System Console
5. Basic operation of Motorola Intrac 2000 Console

PHASE II - INTERMEDIATE OPERATION OF EMCS EQUIPMENTA. INTERMEDIATE OPERATION OF EMCS EQUIPMENT:

- WG-7 {
1. Operation of black and white CRT terminal.
 2. Operation of color CRT terminal and introduction to computer generator graphics.
 3. Basic operations of Level 6 computer.
 4. Basic data collection from field equipment.
 5. Surveillance of HVAC equipment using central hardware and remote sensing devices and microprocessors.
 6. Performing tests on central equipment to insure correct operation of equipment.

B. BASIC ADJUSTMENTS OF DATA BASE PARAMETERS:

1. Basic commands of EMCS computer to provide or modify functions for utility systems cycling.
2. Set point adjustments of data base to reflect changed conditions.
3. Identification of scheduled start/stop programs.
4. Identification of enthalpy controlled programs on HVAC system.

C. DATA FEEDBACK INTERPRETATION:

- WG-9 {
1. Interpretation of information produced by system generated graphics.
 2. Alarm annunciation, problem diagnoses.
 3. Emergency correction of the operating conditions and operating procedures to neutralize alarm conditions.
 4. Collection and maintenance of utility outage reports.

PHASE III - ADVANCED EQUIPMENT OPERATION AND SYSTEM ANALYSIS OF HVAC SYSTEM:A. ANALYSIS OF HVAC SYSTEMS:

- WG-9 {
1. Total data collection of HVAC systems using computer generator graphics.
 2. System Analysis
 3. Computer generated graphics using enthalpy control of HVAC units.
 4. Optimization of HVAC units using unloading and start/stop controls based on seasonal changes.
 5. Total set point adjustments.
 6. Collection and analysis of electrical energy profiles, and usages.
 7. Recommendations for maintenance, repair, modification and replacement of equipment based on system readouts and logging trends of alarms.
 8. Initiation of work orders to support maintenance, repair, modification, and replacement of HVAC or computer requirement.
 9. Assist HVAC specialists in correcting malfunctions through console controlled intercom advising them of type system involved and individual equipment readout of components making up the system. After repair of equipment places equipment back into operation and checks total parameter readout to determine overall system and/or individual system components are operating properly.

B. ADVANCED EQUIPMENT OPERATION:

- WG-10 {
1. Basic programming of Level 6 computer
 2. Basic field programming of 560 field interface devices (FID) and 540 multiplexor units (MUX) using FID Test set.
 3. Basic programming to add new facilities to computer generated graphics software packages.
 4. Historical and operational data exchange from disk to CRT, CRT to printer and all terminals to system.
 5. Initialization of program software and running computer diagnostic routines for system checkout.

WG-10

- 6. Setting up programmed data recordings.
- 7. Diagnosis of central hardware, malfunctions.
- 8. Program all information concerning new points into EMCS data base and program new computer generated graphics equipment schemes.

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